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ABSTRACT

Trends and innovations in science education at two-year colleges are explored in this series of 12 articles. The collection includes: (1) a discussion of alternative instructional modes by John Holleman; (2) a description of the development of a remedial science and biology course for homebound students by Leonard O'Hara; (3) an examination of approaches to teaching ethical decision-making within science courses by Joan Creager; (4) an illustration of the use of "pausing phenomenon" to increase student learning during lecture and discussion by Mary Budd Rowe; (5) an overview of the instructional practices of science instructors in two-year colleges by Jack Friedlander; (6) a description of an individualized, modular approach to mathematics instruction by Myrna Mitchell; (7) an exploration of curriculum design for sociology instruction at community colleges by S. Y. Bradford; (8) a discussion of the use of mathematics placement tests to reduce failure among entering students by June Wood; (9) suggestions for improving science curricula to reduce attrition by Arlene Russell and Patricia Perez; (10) an analysis of the individualized approach to science education by Fred Thompson; (11) a presentation of alternative approaches to the standardized biology course by Bette Slutsky; and (12) an enumeration of the desirable components of an introductory psychology course by Jana Osaze. The monograph concludes with a bibliography of ERIC documents dealing with instruction in 13 scientific subject areas. (JP)

NEW DIRECTIONS FOR COMMUNITY COLLEGES

Teaching the Sciences

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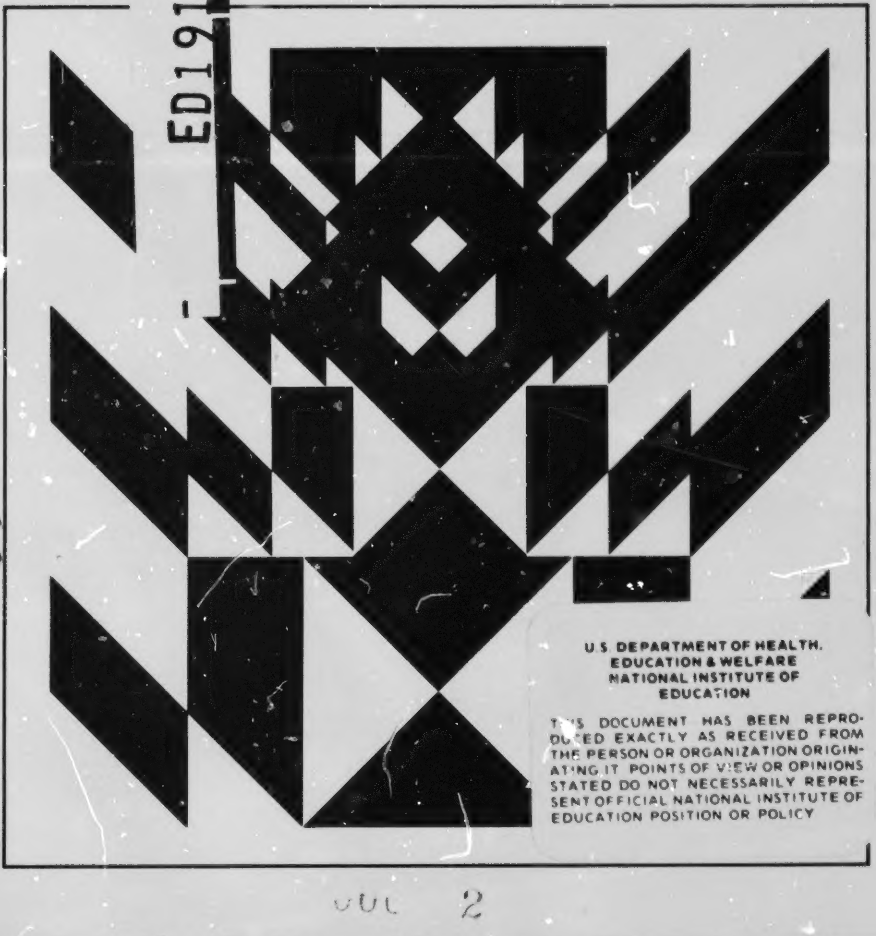

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NEW DIRECTIONS FOR COMMUNITY COLLEGES

A Quarterly Sourcebook
Arthur M. Cohen, Editor-in-Chief
Florence B. Brawer, Associate Editor
Sponsored by the ERIC Clearinghouse for Junior Colleges

Number 31, 1980

Teaching the Sciences

Florence B. Brawer
Editor

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TEACHING THE SCIENCES

New Directions for Community Colleges
Volume VIII, Number 3, 1980
Florence B. Brawer, Editor

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Correspondence:
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Editor's Notes

Half a decade ago, still in the aftershocks from the turbulent 1960s, Volume 12 of *New Directions for Community Colleges* focused on the plight of the humanities in two-year colleges. *Merging the Humanities,* edited by Leslie Koltai, described ways in which both the college and the community might help restore to the humanities a more important role.

Koltai's volume and this present sourcebook form an interesting pair: Koltai has dealt with the humanities, this volume is concerned with the sciences. These two areas, with the addition of the fine and performing arts, comprise the liberal arts. And the liberal arts in most two-year colleges across the country are in danger of slow but almost certain diminution. Even in places where they are reported to be holding their own, they are gradually being usurped by occupational and remedial programs and by ever-expanding community service activities.

Where this present trend will end is uncertain. What is certain is that growing numbers of faculty members and concerned administrators are viewing with alarm the reductions in their course offerings and the need to accomodate a vastly shifting population. They are finding that fewer students are enrolling in the liberal arts because fewer traditional students are on the campuses. The liberal arts courses that are offered are populated by older men and women who take a course here or there and do not actually run the curricular track. Many of these people enroll for personal fulfillment while other students take basic, developmental, or very elementary mathematics and reading courses and shun the liberal arts altogether. Whatever the euphemism for basic courses that is employed by a particular college, the fact is that instructors are being confronted by students who either failed to acquire fundamental skills in high school or who have been out of school for too many years for them to have the necessary skills for functioning in the world today.

This sourcebook, *Teaching the Sciences,* focuses on the actual teaching of the sciences, defined by the National Science Foundation as courses in anthropology, agriculture, biology, chemistry, earth and space sciences, economics, engineering and engineering technologies, integrated social sciences and natural sciences, mathematics, physics, psychology, and sociology. This volume presents ways in which vitality can be injected into courses including basic mathematics to more esoteric interdisciplinary programs. It shows how the sciences can be made meaningful and pertinent to students both on campus and off, and it describes ways in which involved and dedicated faculty members and administrators are attempting to support their disciplines and the comprehensive nature of their institutions by sometimes ingenious and usually enterprising efforts.

As the title indicates, this volume stresses teaching. However, teaching strategies, as we shall see, are manifold and fall into no one pattern. The variety of techniques detailed here suggest some approaches that might be adapted by instructors in other institutions. While almost all of the chapters deal with a particular discipline, in most cases the rationales, the methods employed, and the evaluation of activities can be applied for other disciplines.

Before briefly reviewing the chapters, mention should be made of two important projects now underway that are funded by the National Science Foundation and which directly relate to the topic of teaching the sciences. Both projects are under the leadership of Arthur M. Cohen and are being conducted by the Center for the Study of Community Colleges in Los Angeles. The first is a study of curriculum and instruction in 178 two-year colleges nationwide and has resulted in the publication of twelve monographs dealing with a science discipline or disciplines. Each monograph reports data on curriculum and instruction, cites literature pertinent to its special area of interest, and offers precise recommendations for enriching the teaching of that particular field. These monographs may be ordered through the ERIC Clearinghouse for Junior Colleges, 96 Powell Library, University of California, Los Angeles (UCLA), Los Angeles, California 90024.

The second project is concerned with teaching the sciences to women, minorities, and the handicapped in the nine colleges in the Los Angeles Community College District. Surveys of students and instructors, interviews with counselors and administrators, an investigation of curricular patterns and instruction, and a study of student transcripts (all conducted by the Center for the Study of Community Colleges) will provide information that should broaden our understanding of the ways in which the sciences are affecting students in two-year colleges.

The first chapter of this sourcebook, by John Holleman, is concerned with several disciplines falling under the science umbrella and describes important developments of the 1970s that portend major influences on the present decade. Holleman is a college president who is directly involved with the sciences, and as director of the National Science Foundation-funded "Human Beings and Their Environment," he describes an innovative project on the interaction of people and environments that brought together participants from community colleges nationwide who then developed instructional materials for nine specific environments. Holleman also discusses the "open laboratory," which has expanded biological and physical science courses, and the "investigative laboratory," which is designed around four programmed research projects.

This introductory chapter is followed by another dealing with innovation—in this case, remedial science and biology-at-home courses. Leonard O'Hara is dean of allied health programs at Pennsylvania'a Northampton County Area Community College. As a former biology instructor, he is experienced with remedial science as well as with efforts to extend the classroom to home or prison. Increased time allotments, more hands-on experience, and different sets of goals all are employed to meet the basic purpose of the remedial course: "to teach students how to learn." The second part of O'Hara's chapter describes the biology-at-home course, including necessary laboratory equipment, course syllabus, and study guide.

Joan Creager's chapter carefully illustrates the bridge between the humanities and the sciences that has been noted. Ethics, a discipline that is basic to the humanities, becomes a difficult issue in many courses all the way from the allied health fields to business and industry. Some approaches to teaching ethical decision making in terms of values are pointed out, including clarification, decision-making strategies, and simulation. The examples offered here may well affect all of us at some times of our lives.

Mary Budd Rowe's chapter, which focuses on investigations that have been conducted with an instructional variable called *wait-time,* clarifies how the reader might design and write an experiment replicating the findings of her experiment. Described in detail here is the *pausing principle,* a matter of waiting at specified times during a lecture so that students can share materials and absorb the content of the lecture. Rowe's investigations suggest that wait-time and the pausing principle address the problems of attrition and the students' absorption of proper course material.

Next we move to Jack Friedlander's chapter, which deals with a series of investigations conducted by the Center for the Study of Community Colleges in Los Angeles and reports data that have been derived from studies of curriculum and instructional practices in some 800 institutions across the country. This information, condensed from a series of twelve monographs directed to specific disciplines in the sciences, provides a good measure for administrators and instructors to compare their institutions and their courses with a national sample.

Myrna Mitchell's chapter examines a program that deals with a specific discipline rather than with the sciences on a general level. Involving four to five hundred students and twenty to twenty-five staff members, this complex program is described in considerable detail. Courses offered range from remedial arithmetic and basic algebra to technical mathematics I and II and university transfer courses that include intermediate and college algebra and trigonometry. Each course is modularized into a one-credit segment in order to allow for student pacing, and these modularized/individualized courses have resulted in lower attrition rates while proving to be cost effective.

A somewhat different slant is taken by S. Y. Bradford, who discusses the teaching of sociology in terms of the vast array of community college students who populate our institutions today. Described here are four types of course objectives that provide a vehicle for informality and learning.

June Wood's chapter on placement testing for mathematics reports on a ten-year review of placement testing and changes in test selection and approaches that have taken place at her institution. In the 1960s, a review course was developed at what was then South Texas Junior College (now the University of Houston, downtown campus) for students who were not adequately prepared for college algebra. A placement test was devised to screen students continuously throughout every registration period and to place them then in special math courses. An assessment of enrollment changes after ten years of placement testing suggests that offering these multilevel tests has resulted in a steadily increasing enrollment and a higher retention of students.

In another sphere of concern, Arlene Russell and Patricia Perez discuss the problems of two-year college students who have difficulty with science courses at the university to which they have transferred. The problems of attrition are pervasive and hit all points on the spectrum. Much of the data reported by these authors therefore pertains to university people as well as to two-year college personnel. Differences in textbooks, lack of adequate preparation, varying course levels, and lower mathematical requirements are all described here as possible handicaps to a student who transfers to a university.

Fred Thompson's chapter on a systematic approach to individualized instruction focuses on the identification of students and the defining of objectives. Thompson draws upon his own field of economics to describe ways that these learning objectives can organize course materials for instructors and students alike, provide a vehicle for a cooperative learning process, help in selecting examination questions, and form a basis for establishing criteria for each concept area.

A viable alternative to a general education biology course is described in Bette Slutsky's "Alternatives to the Standard Biology Course." This course is designed to help students understand the structure and function of women's bodies and may be used in lieu of another biology course for general education credit.

The final chapter, by Jana Osaze, deals with the psychology of teaching psychology. Osaze's chapter describes several inventories that have been found to be helpful to students who require not only some content or cognitive feedback from their psychology course but also look to the course as a way of dealing with their own personal problems and personal issues.

In addition to these teaching chapters, Donna Sillman has compiled a bibliography for further information. References cited here are all available through the ERIC system. I am most grateful for the work of Bonnie Sanchez, associate director of the ERIC Clearinghouse for Junior Colleges at UCLA, who has been most helpful on all phases of this project. Given a short time in which to put this volume together, she was responsible for many of the phone calls and contacts with authors and for generally keeping the volume in shape.

Florence B. Brawer
Editor

Florence B. Brawer is a research educationist at the ERIC Clearinghouse for Junior Colleges at UCLA. She is also research director of the Center for the Study of Community Colleges.

The science instructional innovations of the 1970s could become the traditional modes of the 1980s.

Recent Innovations in Science Instruction

John J. Holleman

Recent developments in community college science instruction had their impetus in a series of publications in the 1960s and 1970s. These articles and texts focused on the needs for educational innovations and motivation of student learning. A number of science instructors in community colleges were eager to adopt the new ideas and technological advances to their needs—an interest perhaps best evidenced by the more than 350 participants attending an Audiotutorial System conference in 1969.

As the 1970s progressed, three major developments occurred that are now beginning to bring about changes in the methods of science instruction in community colleges. As science faculties have increased their use of modular instruction, they have also developed new approaches to the science laboratory, which can best be termed the *open laboratory* and the *investigative laboratory*. Another development that has emerged from the seventies is the interdisciplinary approach to environmental studies, which broadens the traditional narrow disciplinary perspective and leads to a much more complete understanding of the environment.

Interdisciplinary Developments

R. A. Dodge reports a statement by the education committee of the American Institute of Biological Sciences: "Traditional biology programs are rapidly becoming anachronisms for too large a segment of the constituency of higher education" (1976, p. 6). This same concern has been expressed by Pattison and Natoli (1977) for geography. Both statements display the recognition that traditional science instruction tends to be more oriented to the subdisciplines of specific fields rather than to broader interdisciplinary areas. As Dodge notes, the time has come: "to devise programs that explore biology as it pertains to every citizen's life, environment, mental and physical health, and political decisions" (1976, p. 7). Dodge's remark can be applied not only to the concerns of biologists but also to those of many physical scientists. Science faculties of numerous community colleges have responded to this issue by proposing and/or implementing interdisciplinary environmental studies programs that provide this broader perspective to their students.

"Human Beings and Their Environments"

In the fall of 1976, seven science faculty and nine science-related administrators from eleven community colleges convened to discuss their concerns about the separateness of their disciplines as they were being taught. The participants proposed a pilot program that would bring together faculty from community colleges across the United States in an interdisciplinary institute. This proposed program developed into "Human Beings and Their Environment," a project funded by the Development in Science Education Division of the National Science Foundation. The program was designed to focus on a research laboratory experience for an interdisciplinary group of faculty.

The concept of "Human Beings and Their Environment" was unique for community colleges from its inception. As the concept developed out of the initial planning meeting, it was determined that the goal of the project was to be the development of interdisciplinary instructional materials in science education that focused on human beings' impact on their environments. The objective was to improve science instruction through the use of the interdisciplinary materials to demonstrate to students the relationship between scientific concepts and the results of human actions on their environment.

The project proposed to develop instructional materials that focused on nine geographically and environmentally diverse environments. The areas selected had regional and national importance, and each provided a natural laboratory setting. This concept was not new, but the idea of uniting community college faculty at a natural laboratory site in order to develop instructional materials was a novel one. The natural setting provided a basis for the production of more relevant and timely materials.

The participants in the project were recruited from fifty-one community colleges across the nation. Thirty faculty from twenty-one colleges representing eleven disciplines as diverse as anthropology, botany, business history, and political science were selected to participate in two field laboratory institutes. By working in interdisciplinary groups, participants could consider the concerns of regional planning on local, state, and federal levels, as well as on the issues of conservation, business, and recreation.

The first two field laboratory programs were held in the Mojave Desert and in the northern Sierra Nevada of California. The general format of the programs involved lectures and field research. These experiences provided the basis for the development of the instructional materials in a module format, an effective form of instruction (Beishir, 1976; Case, 1980; Hechinger, 1976; Jenkins, 1977; Johnson and Johnson, 1975). The participants working in interdisciplinary groups developed modules in the following major areas:

1. Natural history of the environmental site.
2. Current state of the site environment.
3. Methods used by human beings to bring about positive or negative environmental changes.
4. Future prospects and problems of the site.
5. Development of action strategies that students and citizens can utilize to protect and improve the environment.

In addition to these major modules on each environmental site, mini-modules on smaller and more specific topics were developed by individual participants, reflecting their particular interests. Topics of these mini-modules varied from stream erosion to land use control to damage caused by off-road vehicles.

The modules were submitted to field testing with peer and student reviews. The reviews cited the strength of content, organization, and illustrations (slides, diagrams, and tables) as particularly strong elements of the modules. Students indicated the clarity of the modules enabled them to successfully complete the instructional unit. Both student and peer reviews indicated that the five major modules of both sites would have use in a number of science, environmental studies, and interdisciplinary studies programs.

The instructional potential for these materials is great. The major modules can be used together to form a course that focuses on man's effects on different environments and actions that can be taken to correct negative results. When the study of all nine environmental sites is completed, the modules may be grouped in a number of combinations. The natural history modules form a logical grouping for ecology and environmental studies courses. The modules dealing with the current state of the environment, future problems and prospects, and action strategies can form the major elements of special environmental study courses on public policy and the environment. The full complement of modules can be used in regular science course as supplementary work or as independent study options for community college students.

In addition, the major modules can be utilized in citizen-oriented science education programs. The concern that human beings are not as aware of their impact on the environment as they should be will be addressed by these modules. The timely nature and ease with which modular concepts can be transferred and adapted to other environmental areas increase the specificity, effectiveness, and utility of the modules.

Open Laboratory

The development of open laboratory programs is expanding in community college biological and physical science courses as the use of modules and individualized instruction is increased. The objective of an open laboratory program is to enable the student to work at times that are convenient for him. Case (1980) states that the flexibility that students have in scheduling the laboratory when the autotutorial approach to instruction is used enables students to enroll who might not have because of time constraints. The student has the opportunity to spend as much time in the laboratory, either in one visit or visits over several days, as is necessary to complete the assignment.

The way an open laboratory is structured depends on the individual instructor. Jenkins (1977) reports on two geography courses that use an elaborate audiovisual-tutorial instructional method. The courses involve two detailed manuals that direct students through study exercises that involve tape cassettes, 35mm slides, short films, and geographic models. Reeve (1973) has developed an open laboratory program for general education life science courses for non-biology majors that includes twelve assignments, four field exercises, and two optional exercises. Case (1980) has divided the laboratory into fifteen minicourses, each of which includes a study guide, tape cassette, 35mm slides, laboratory experiments, optional activity and posttest. Postlethwait and Russell (1971) have developed an approach structured around a self-instructional learning carrel. Their program involves objectives, programmed audio tape, student study guides, various forms of visual aids, and relevant biological materials.

The material used in the open laboratories varies from course-specific materials developed by a single instructor or group of instructors to commercially produced materials for broad general courses. The chemistry department at Merritt College in Oakland, California has used the open laboratory format for large freshman classes for the past five years. Regular laboratory manuals are used with experiments, and assignments are made for specific weeks. If the student is unable to complete the assignment within the time specified, times are provided for make-up.

The open laboratory provides students with as much time as necessary to complete and learn the instructional material presented. Numerous studies (Baker, 1970; Case, 1980; Holleman, 1977; Myers, 1977; Sparks and Unbehaun, 1971) have investigated the effectiveness of the open laboratory utilizing an autotutorial or audiovisual approach. In all these studies the students in the open laboratory program achieved as well as or greater than students who were enrolled in a traditional laboratory program. The student's reaction to the open laboratory programs is positive—students know they are learning and are responsible for their own achievement.

Investigative Laboratory

Thornton (1972) reports the results of a Commission on Undergraduate Education in the Biological Sciences panel charged with resolving the function of the instructional laboratory in biology. The panel concluded that with everything considered, the greatest priority of the laboratory should be investigative. The objectives of the investigative laboratory should be first to understand the processes by which knowledge of the different disciplines is obtained and revised, and second to provide necessary experience for students to develop the processes ascribed to scientific thinking.

Individualized instruction leads naturally into the investigative laboratory. Burke (1979) reports on an investigative laboratory in microbiology. The laboratory was designed around four programmed research projects that introduced scientific investigation to the students. With some variation, the investigative approach is also being used in geology (Sugent, 1977) and geography (Kiester and Kiester, 1977).

The investigative laboratory, no matter how structured, has proved to be stimulating to students. The student-teacher relationship is enhanced with the investigative laboratory approach. The teacher by the very nature of the laboratory must be ready to discuss each student's project individually, giving guidance and assistance if necessary. As Holt has stated: "The investigative laboratory can provide the vehicle for more informal student-faculty interactions of the type increasingly sought [by students]" (Holt and others, 1969, p. 1106).

The directions that community college science instruction began in the 1970s will continue to expand in the 1980s as science faculty recognize that newer approaches to science instruction do motivate student learning. In the 1970s, the National Science Foundation provided support to assist faculty in redesigning courses and developing new instructional approaches. The National Science Foundation has not only been concerned with instructional development but also with faculty development; however, it is becoming increasingly apparent that faculty development has not kept pace with subject matter and instructional development. There are signs that the National Science Foundation is beginning to realize the need for updating the science faculty whose primary instructional responsibility is for lower-division and undergraduate students. If this results in expanded science faculty development programs with increased opportunities for community college faculty participation, the innovations begun in the 1970s will become the accepted procedures of the 1980s.

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John J. Holleman is president of Vista College and director of the project "Human Beings and Their Environment." Prior to assuming his position at Vista College he was a biology instructor and division chairman of science and mathematics at Merritt College.

A well-designed introductory biology course can serve as a point of departure for the construction of special offerings, including remedial science and biology for homebound students.

Biology Course Innovations: Remedial Science and Biology-at-Home

Leonard F. O'Hara

No course in the biology curriculum is as important as introductory or general biology. Usually it stands as a prerequisite for all other offerings and, if thoughtfully constructed, can reflect the teaching/learning style and educational philosophy of the department.

At Northampton County Area Community College (Pennsylvania), general biology is a one-semester offering that focuses on basic and traditional subject matter areas. The text and laboratory manuals are of prime importance since all else flows directly or indirectly from them. Classroom sessions are of the lecture type and employ a number of visual aids and demonstrations. Laboratory assignments parallel lectures and, for the most part, are of the standard or traditional variety, illustrating basic principles as well as familiarizing students with the tools and organisms upon which the study of biology is grounded. In form, then, one would readily conclude that the course structure is unremarkable. However, this absence of flamboyance is not an incidental occurrence. Before this program was adopted, several less traditional approaches, including Purdue's very fine autotutorial method, were thoroughly investigated and rejected, not because they were ineffective but because they were less compatible with departmental philosophy than the more standard approach. This general biology format has proven satisfactory for the past eight years, during which time the course has undergone constant updating and modification. In fact, the ease with which the traditional arrangement lends itself to alterations has proven to be one of its greatest strengths.

All departmental faculty are involved in general biology; each brings to it an individual emphasis and style. As a result, while topical areas are fixed, students in different sections of the course are treated to different approaches dependent upon which instructor they choose. Department faculty also benefit from each other's strengths and subject matter expertise by coming together on a regular basis to discuss the course. The product of this sharing and fine tuning is an effective course that has demonstrated resilience and adaptability in demanding situations.

The most notable of these adaptations are a remedial science course, "Understanding Living Things," and an at-home version of general biology. The former gives students with limited or no scientific background an opportunity to learn how to learn, while the latter brings everything except campus climate to students who are unable to attend regular in-school sessions.

Remedial Science

The idea of creating a remedial science course at Northampton surfaced in the early 1970s as a result of a lengthy in-depth review of the entire curriculum. Among other things it was concluded that the remedial or developmental program needed substantial revamping. In addition to the perennial questions of whether such courses should carry college credit (if not, would students decide not to take them?) and whether an open-door institution should allow students to bypass remediation and give them the right to fail if they so choose, a concern emerged for wholly remediating the student.

Proponents of this holistic approach argued that students need help in more than basic reading, writing, and mathematics, and suggested that the science areas presented a particularly difficult hurdle for the poorly prepared or slower learner. They also insisted that if the institution wanted to increase the chances that students forced into remediation would elect to stay with the process long enough to see positive results, then more stimulating courses would have to be made available to them. Otherwise, remedial students would be likely to take regular credit courses while they learned to read, write, and do mathematics—an approach that could turn the open door into a revolving one.

The holists won the day but their victory was short lived. A developmental science course, described below, was developed but was offered only once. Its demise was due to a change in biology personnel and a lack of institutional commitment to this approach to remediation.

In 1979, during another curricular housecleaning, the remedial science course was nearly removed from the catalogue because it had not been taught for several years. Very recently, however, interest in all forms of remediation has begun anew. Sometime before the final Carnegie Report (Scully, 1980) heralded the coming of hard times for higher education, this institution had evidence that many more of its students would be coming to college with narrowly defined goals and/or serious deficiencies in basic skills. Shrinking numbers of eighteen- to twenty-two-year-olds and lack of public confidence in education compound the problem. As the commission noted, when faced with these conditions some colleges might do anything to curry student favor, including lowering their standards. Fearing threats to fiscal well-being and curricular integrity and, at the same time, wishing to serve the needs of the developmental student, Northampton County Area Community College (NCACC) has assembled a task force to study the matter. The resurrection of remedial science may be one way to cope with the problem.

One of the truly beautiful aspects of being a teacher of basic biology is that the facts and principles that comprise the subject matter can be learned and understood by practically everyone. The only things that the teacher must be concerned about are that the level of instruction is compatible with the level of student sophistication and that the instructional process produces desired outcomes. This amoebic nature made biology the logical discipline upon which to build remedial science. The existence of a solid introductory-level course in the credit curriculum made the task infinitely more simple.

Based upon institution-wide deliberations, it was clear that the goals for the new course would have to be different from those one finds in the usual biology course. While facts and principles would form the bulk of what was taught, the true purpose of the course would be to teach students how to learn. With this in mind, several goals were established.

1. To improve the student's ability to read and comprehend basic scientific writings.
2. To improve the student's ability to write, placing special emphasis on scientific material and style.
3. To develop within the student the knowledge that success in basic science is no less attainable than it is in any legitimate college-level subject.
4. To prepare the student for eventual entry into regular college-level science courses.

The time allotted for completing most assignments was lengthened and more hands-on experiences were provided. Otherwise instructional objectives developed for each lecture and laboratory assignment were remarkably similar to those employed in the credit course; only the mode of presentation was altered. A brief comparison between the regular and remedial courses will illustrate the similarity.

Thus, it was in the laboratory format that the new course made its only major instructional departure from the standard version. The decision to use *nature* itself as the lab was made in the hope that these fledgling scientists would

Table 1. Comparison of Regular and Remedial Biology Courses

	Understanding Living Things	*General Biology*
Weeks/Hours of Instruction	15 weeks/75 hours Lab/Lecture split: Flexible	15 weeks/75 hours 3 hours Lecture/2 hours Lab per week
Course Credits	4 credits, limited applicability toward graduation requirements.	4 credits, applicable toward all degrees.
Text	Keeton, William T. *Elements of Biological Science* (2nd ed.) (New York: Norton, 1973).	(same)
Text Assignments (3 to 4 weeks per topic)	Part 1: Ecology, The Diversity of Life Part 2: Organisms—Structure and Function Part 3: Cells, Structure and Function Part 4: Evolution (Limited Study of Genetics)	Part 1: Chemistry—Cellular Structure and Function, Energy Transformations Part 2: Organisms Part 3: Genetics and Evolution Part 4: Ecology, The Diversity of Life
Tests	4 Lecture Tests (essay); 10 Lab Quizzes (objective).	4 Lecture Tests (mostly objective); 10 Lab Quizzes (objective).
Laboratory Exercises	80 percent of the laboratory conducted in the field with emphasis on experiencing phenomena then communicating about them. The remaining 20 percent taken from the regular laboratory (microtechniques, taxonomy, dissection, physiology).	15 exercises, 9 taken from Keeton and others, 1970.

come to see the study of biology in the broadest possible perspective, thereby increasing the likelihood that each student would develop an affinity for and interest in the subject matter through his or her own experiences. A typical laboratory day would involve a trip to a local nature sanctuary or a stroll through the woods and cornfields that surround the campus. Later, or on days when the weather would not permit outside work, materials that had been gathered and classified would become the subject of more rigorous scientific investigation indoors.

For me, as the developer and instructor of the course, it was an extremely pleasant and professionally rewarding experience. Unfortunately, it was not taught often enough to know if it could accomplish all of its goals.

At-Home Learning

For many people, the only thing in the way of getting an education is their inability to come to the formal classes. Possessing the ability and desire to learn, they need only find a way to have the educational process brought to them. Colleges and universities have traditionally either turned these applicants away or offered correspondence courses for them. But since such correspondence course typically do not carry regular college credit, they are not satisfactory alternatives. The extended college concept came into being to overcome this drawback and to allow schools to capitalize on the growing appeal of media as formal instructional tools (witness the plethora of newspaper- and television-based courses for credit that have surfaced during the past decade).

In 1972, Northampton received a federal grant to assist the college in its efforts to construct a program of learning that could lead to an associate degree (sixty credit hours) for students who were unable to come to the campus. The primary target populations were to be homemakers, handicapped individuals, prison inmates, and those living at or beyond the normal service boundaries of the campus. Since that time, the college has established satellite campuses to accommodate the last group, but the absence of sufficient enrollments has still made the scheduling of science courses impractical.

The conversion of on-campus offerings to an at-home mode took place over a span of several years and was accomplished with varying degrees of difficulty. In most cases faculty simply wrote study guides that paralleled texts and other reading assignments and mailed these to the student along with information explaining the logistics of handling testing, grading, and periodic consultation. Other instructors chose to make more elaborate changes in course format, but their task was a straightforward one compared to that undertaken by the biology department.

Insofar as could be determined, no institution in the nation had developed a laboratory science course that students could do entirely at home. Indeed, some faculty suspected that it could not be done, at least not with any degree of integrity. In the end, it was faculty confidence in the strength of the general biology course that led to the decision to try to develop this course.

General Biology at Home. Anyone who has taught or merely taken an introductory-level college biology course can testify to its logistical or tactical complexity. The subject matter is not that difficult, but the language frequently presents a serious barrier to understanding. The essential tools of the trade are familiar enough to most beginning students, but their proper use is often difficult to convey because many have mislearned techniques or learned them in ways that are unacceptable to the current course instructor. Handouts abound, and these, as well as directions for carrying out laboratory or reading assignments, seem to require constant modification or clarification. Moreover, students want and need frequent reassurances that all is going as it should. These problems of tactical complexity and communication were magnified as we developed a course to be learned without a teacher present. And the task of transporting the laboratory to the learner seemed insurmountable.

Before attacking logistical and laboratory problems, certain givens were agreed upon. First, if after devising the best course possible, the department did not agree that it was as rigorous and thorough as the on-campus version, then it would not be implemented. This did not mean that both courses would contain exactly the same learning experiences (obviously they could not), but rather that the at-home variety would be of sufficient quality to withstand careful peer review. Second, the grading system would be the same for both courses. Not only would a 90 percent performance earn a grade of "A," 80 percent a grade of "B," and so forth, but performance on the laboratory portion of the course would constitute one half of the total course grade. Third, since no present member of the faculty had the time or inclination to undertake the entire project, a master's degree-prepared biologist would be hired to do the basic planning and writing and I, as department chairman, would serve as project supervisor.

The first order of business for the new staff member was to review the entire general biology course from the perspective of one who had had no previous exposure to it. To the furthest extent possible, this course review was also intended to simulate the conditions of the at-home student. As a result, chapter-by-chapter guides were written and the course syllabus was expanded. Directions were made as explicit as practical, and any faculty departures from or disagreements with textual material were so noted. (For example, one could no longer afford to wait until a model of a sodium-potassium pump came up in class to explain that many of the aspects of the model had been clarified since the printing of the text.) This information had to be included in the study guide so that the at-home student would not panic or get bogged down in a less than crucial concept.

The review exercise revealed another important aspect of at-home teaching, one that has resulted in improved teaching on-campus as well. In attempting to be as clear as possible, the developers found that they were eliminating other barriers to student learning. By forcing the issue of telling at-home students exactly what was expected of them, the syllabus and related materials were stripped of faculty doubletalk to reveal the mindset of the teacher. This element of learning—finding out the instructor's *exact* position regarding the course and the student—has long been recognized by students as a key to success in higher education.

Study Guide. The combination syllabus/study guide has emerged as a wide-margined, double-spaced, fifty-page document dealing principally with the lecture portion of the course (for a copy contact this writer). Its content is little more than a refined version of my lecture notes: key words and concepts from each reading assignment that, when condensed and scrawled on the blackboard prior to a given lecture, help to alleviate the student complaint of being unable to tell when the "important" material leaves off and the "wild tangents" begin.

Laboratory. Without question, the laboratory portion of the course presented the greatest challenge. Not only did the directions have to be clear and nearly foolproof but exercises also had to be capable of being done outside the formal laboratory and in the absence of the instructor.

Predictably, the developmental process began with what already existed, the on-campus general biology laboratory exercises. The finished product, a sixty-one-page laboratory manual, makes extensive use of illustrations, tables, and readings found in the text. Each of the fifteen exercises has been field-tested, and all but three have been taken wholly or in part from the regular course. A list of the laboratory titles reveals their compatibility with most freshman-level biology offerings:

- The Microscope
- Microtechniques
- pH and Enzyme Activity
- Digestive System of the Fetal Pig
- Respiratory System of the Fetal Pig
- Urogenital System of the Fetal Pig
- Human Physiology I
- Human Physiology II
- Monohybrid and Dihybrid Crosses—Genetic Crosses
- Population Dynamics
- Taxonomy and Classification
- Lower Plants
- Mold Growth
- Higher Plants
- Nature Study

Laboratory assignments closely parallel those in the text and students are required to maintain a record of the work they have done. By carefully constructing these lab requirements and by tying quiz questions to the work that students perform, the possibility that students might not do the work themselves has been minimized (for instance, dissections must be presented to the evaluator, and questions or return demonstrations on the actual dissection process are part of the testing procedure).

Laboratory Kit. Each enrollee in the at-home general biology course receives a laboratory in kit form. This kit was valued at $225 when assembled in 1975, most of which went for the microscope and carrying case. In addition, students are frequently told to supply common household items. They are also directed to use their own anatomy and physiology to illustrate a variety of phenomena.

The course has worked surprisingly well. It has fulfilled the needs of

Table 2. Supplies for At-Home General Biology Laboratory

- Microscope
- Microscope Carrying Case
- Slide Box (Plastic)
  - 4 Blank Slides
  - 1 *Spirogyra* Conjugation
  - 1 Human Blood Smear
  - 1 Fern Prothallus
  - 1 Fern Sori
  - 1 Moss Gametophyte
  - 1 Mixed Diatoms
  - 1 Moss Capsule
- Kodachrome Slide Series
  - 18 Fetal Pig Slides
- Reagents (Liquid)
  - 12 ml. .IN HCL
  - 12 ml. .IN NaOH
  - 10 ml. Wright's Stain
  - 10 ml. Iodine Stain
  - 6 ml. Universal Indicator
- Dissecting Kit
  - Scalpel
  - Blunt Probe (Metal)
  - Ruler
  - Eye Dropper
  - Scissors
  - Teasing Needle
  - Forceps
  - Fetal Pig
- Dissecting Tray
  - 1 Polyglove
  - 2 Pieces String
  - 1 Tripod Magnifier
  - 1 Test Tube Stand
  - 10 Test Tubes
  - 7 Mouth Pipettes (Sterile)
- Envelopes
  - 1. Dissecting Needles (12)
    Eye Droppers (3)
  - 2. Dry Yeast
  - 3. Nutrient Broth (in foil)
  - 4. Sterile Lancets (2)
    Alcohol Pads (2)
  - 5. PTC (Taste) Paper (6 strips)
  - 6. Lens Paper (12 pieces)
    Cover Glasses (slips) 1 packet
  - 7. Manganese Dioxide or Iron Filings (in foil)
  - 8. Eye Chart with Directions

the students and the quality requirements of the faculty and, in the process, has brought about improvements in the regular biology course. One aspect of the implementation phase that has helped reduce problems is that most students have been able to come to campus every four weeks to take the required tests and quizzes and to turn in laboratory assignments. Those who could not come to the school have been tested by professionals in their local areas, and prisoners have been visited by course instructors. Regularly scheduled telephone conversations with the instructor take the place of office hours; emergencies, too, are handled by phone.

There is little question that, given the choice of on-campus or at-home study, all faculty and most students would select the former, if for no other reason than the stimulation that classroom interaction provides. Still, for those who have no such alternative, the at-home general biology course has proven to be a more than satisfactory substitute.

Summary

Once the format and style of the basic biology course have been established and agreed upon by the department, it can be used as a point of departure for less conventional ventures. This chapter has described two such undertakings. The first was a remedial science (biology) course entitled "Understanding Living Things." In this course, developmental students were exposed to most of the same material found in basic general biology courses. Instead of placing primary emphasis on learning the discipline, however, students used their experiences to aid them in improving communication skills. I believe that courses like remedial science might decrease the attrition rate of such students and at the same time help institutions resist the temptation to lower standards in order to maintain enrollments.

The second variation of the basic course came in the form of a general biology credit offering that can be completed at home. The lecture portion is virtually identical to that found in the on-campus version, except that the enrollee is provided with a greatly expanded course syllabus and a chapter-by-chapter study guide. The fifteen laboratory assignments closely parallel those performed on campus. To complete them, the student is loaned a kit containing the necessary equipment and supplies.

References

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Leonard S. O'Hara is dean of allied health and associate professor of biology at Northampton County Area Community College, Bethlehem, Pennsylvania.

Concern about the ethical implications of science and the availability of methods for ethical decision making compel science teachers to teach ethical decision making.

Teaching Ethical Decision Making

Joan G. Creager

Ethical decision making can and should be taught in science classes. In the past, science teachers might have argued that their task was to teach science—concepts, facts, and methods. Today, many science teachers recognize that they must help students learn to make decisions about the uses of science and technology. How has this come about?

First, our knowledge of science has been expanding and continues to expand at an exponential rate. Likewise, technologies based on scientific discoveries have grown at a tremendous rate. Many new possibilities exist for how we might use science and technology.

Second, many of these technologies came into use before their ethical implications had been fully explored. We began using life-support systems in medical emergencies before we had determined the conditions under which we might be justified in "pulling the plug." We implemented industrial technologies before we had determined their effects on the environment. And we continued to use energy supplies and natural resources at increasing rates before we had considered the consequences of their depletion.

We therefore know that citizens, regardless of whether they have chosen science-related careers, will be faced with political and personal decisions about the uses of science and technology. Some will serve on civic committees or hold public offices; all will vote on issues involving science and technology. All citizens will have to make decisions about themselves and their families on matters of health. In turn, community college students training to enter the health professions will need to make ethical decisions about their own behavior in the care of patients. Students entering other science-related careers will be faced with decisions about environmental quality, conservation of natural resources, and development of new technologies to provide energy and goods.

We now have available teaching methods to help students clarify their values and learn to make ethical decisions. The remainder of this article will explain some of the available teaching methods and provide examples of their use.

Approaches to Teaching Ethical Decision Making

Current approaches to teaching ethical decision making include values clarification, decision-making strategies, and simulation. These approaches are intended to offer students a way to consider alternative solutions to problems and to make rational choices based on their own values. These methods do not tell students what their values should be nor do they allow instructors to indoctrinate their students with their own values.

Values Clarification. Values clarification was one of the earliest methods of helping students to consciously think about and choose their own values. Raths (1966) contends that great diversity exists among people in the clarity of their values. Some know what they have to give to society and what they want to get out of their lives. They live their lives with enthusiasm, purpose, and pride. They see things about society that need changing, but they go about fostering these changes in positive and constructive ways. Others seem not to know what they want or what they can contribute. They exhibit apathy, uncertainty, and inconsistency. They may be extremely conforming or extremely nonconforming to the behaviors of the rest of society. The former have clearly defined values; the latter may suffer from a confusion of values.

The techniques of values clarification developed by Raths, Harmin, and Simon (1966) are based on their studies of how people arrive at and clarify the values they hold. From their studies, we can define a value as something that is important in human existence and that meets the following criteria:

1. Choosing freely—values must be chosen by the individual to be really valued.
2. Choosing from among alternatives—alternatives must be available to make a free choice.
3. Choosing after thoughtful consideration of the consequences of each alternative—careful and intelligent weighing of consequences must replace impulsiveness if true values are to emerge.
4. Prizing and cherishing—choices result in values we are pleased to hold.

5. Affirming—willingness to publicly affirm values results from having made conscious choices that we prize.
6. Acting upon choices—our real values guide our actions; verbal affirmation is not enough to show that a value is real.
7. Repeating—values tend to persist, to make a pattern in life.

The instructor's role in values clarification in the classroom is to create situations in which values clarification can take place, to encourage students to examine the consequences of all alternatives, and, especially, to avoid making judgmental comments. These tasks can be accomplished in several ways.

Creating situations in which values clarification can occur is the simplest of tasks. Nearly every science course includes some content that has ethical implications. The news media give examples daily of applications of science that have led to ethical dilemmas. The setting and maintaining of environmental standards is related to the content of many science courses. Population growth, nutritional standards, and genetic engineering are related to the content of an introductory biology course. The allocation of scarce medical resources, euthanasia, abortion, and many other medically related issues arise in courses for health science students. An instructor need only take some time from the transmission of content to address these issues.

To encourage students to examine the consequences of various alternatives we need to present some alternatives for them to consider and to allow them to suggest other alternatives. For example, in a unit on factors that control population size, we might present the students with the following statement from Tertullian (about 200 A.D.): "The strongest witness is the vast population of the earth to which we are a burden and she scarcely can provide for our needs; as our demands grow greater, our complaints against nature's inadequacy are heard by all. The scourges of pestilence, famine, war, and earthquakes have come to be regarded as a blessing to overcrowded nations, since they serve to prune away the luxuriant growth of the human race" (in Hardin, 1964, pp. 22–23). This statement should be followed by questions leading to a general class discussion:

1. What does this statement imply about the value of human life?
2. How does the statement compare with today's understanding of the factors that control population size in natural ecosystems?
3. What alternatives to catastrophes are there to control human population?
4. Which alternative would you choose and why?
5. How do your actions reflect your values?

The purpose of this activity is to enable the students to consider alternatives and make individual choices. Instructors may provide any amount of scientific information; they may even express values if students want to know their instructor's views. However, it is important to recognize that if the students are to arrive at their own carefully thought out values, they must not feel pressured to adopt the instructor's values.

Many instructors ask: "How do you grade such an activity?" One answer is that you do not grade it. Another is that you simply allot a portion of the total grade for completing the activity. Clearly, one should *not* evaluate choices made by the students.

Decision-Making Techniques. While values clarification provides students with a method for considering alternatives and making a choice of the best alternative, it fails to deal with decisions in which several values may be involved. Kieffer (1979) offers a more sophisticated decision-making technique. The steps in his method include:

1. Stating the problem.
2. Determining the possible courses of action.
3. Stating the values or moral judgments involved in each course of action.
4. Rank-ordering the values.
5. Deciding the course of action most consistent with the highest ranking values.

Kieffer (1979) recommends the case study approach as a way to teach students to use this method. We will select for our case study the topic of vegetable proteins; we will begin by stating our problem as a question: Should humans in an affluent country be required to obtain their proteins from vegetable sources? In a course in chemistry or biology, the topic of proteins and how they are used by living organisms might arise. The instructor might provide students with information on the various types of amino acids in proteins from different sources and on the kind and amount of protein needed by the human body. Included in this information would be the fact that humans can obtain all amino acids they need from vegetable protein sources and thereby place less demand on the ecosystem in which they live. (See Lappé, 1971, for more information on vegetable proteins.)

Now that we have our problem clearly stated, we must list *all* possible courses of action. The tendency is to answer the question with a simple yes or no, but students should be encouraged to consider a variety of possibilities. For example, students might propose that certain groups of people obtain proteins from vegetables or that all people obtain proteins from vegetables some of the time.

When several courses of action have been proposed, all values that bear on each course of action should be listed. Listing these in writing helps to clarify the thinking about them. For example, for the alternative that all humans should obtain proteins from vegetables, we might list the following values: (1) rights of the individual do not include the right to eat animal proteins unless all humans can eat animal proteins; (2) society has the right to prevent some people who can afford animal proteins from consuming them if all citizens cannot afford them; (3) discrimination against any group of citizens is unethical; and (4) enforcing rules to cause people to consume vegetable proteins would require expenditures of tax money that might be better spent for other purposes. Similar lists should be made for each of the alternatives. Students should be prepared to give rational reasons for the values they include in each of their lists. Furthermore, they should list the values related to each alternative before choosing one of the alternatives. Kieffer (1979) notes that this process engages students in a serious search, the most instructive part of the process.

Rank-ordering of values is another difficult part of this procedure, but it is an extremely important component. In fact, we might define ethics as the rank-ordering of values. Individuals may very well rank the values in different orders and, unfortunately, no method currently exists to provide moral absolutes by which the ranking can be done.

Some guidelines for ranking values can be offered. Students might ask themselves whether they could live with a decision based on any particular value statement. For example, would the student be comfortable living in a society that prevented people from eating animal protein? Another method for testing the validity of an ethical choice is to look for an ethical universal—a moral principle that applies to all people at all times (for example, the principle that discrimination against any group of citizens is unethical under any circumstances). Finally, one might apply the principle of proportionate good. We could assert that eating vegetable proteins harms no one and that it makes protein available to more people. The greater the number of people helped, the greater the proportionate good.

Once these guidelines have been used to rank-order values, some alternatives will have higher rankings than others. The alternative with the most highly ranked values might be the one chosen. If the problem is one of individual choice—one person's decision to eat or not to eat vegetable proteins—the technique might be concluded at this point. However, more than one alternative may have highly ranked values, therefore necessitating a choice among these values. The individual must acquire further information about the issue and reevaluate rankings until she or he can arrive at an acceptable choice.

This technique can be expanded to group decisions or policy making. For example, the issue of who eats vegetable protein under what circumstances might be addressed by a governmental body. Decision makers would be required to reach consensus on the issue by identifying tradeoffs among the values implied by each decision. Individuals in the group who oppose society's dictating that some people cannot have animal proteins unless all can have them might agree that every member of society should be limited to a specified amount of animal protein over a given period of time. The group might use a balance sheet for weighing highly ranked values for each alternative to arrive at the selection of one alternative that accommodates the greatest number of highly ranked values for the greatest number of members of the group.

Students, in turn, could be asked to form small committees of from five to seven individuals. Each committee would use the decision-making technique to arrive at the most acceptable alternative on a given issue. A general class discussion of the proposals of each group might also be used.

Role-Playing Simulation Techniques. Simulated situations can be used to create conditions similar to those students may encounter as citizens or in activities related to their employment. Such situations create a learning environment in which students can learn to deal with issues that might arise in real situations. Though other kinds of simulations exist, here we will focus on role-playing simulations because they are particularly effective in helping students to learn how to address ethical issues. The following steps, adapted from Lehman (1971), are involved in using role-playing techniques.

1. Design a simulated situation.
2. Prepare a short description of each of the roles to be used in the situation.
3. Describe the situation to the class and assign roles.
4. Carry out the simulation.
5. Critique the simulation.

In designing such a simulation, it is important to select a situation that has real significance to the students. It should address an issue they may encounter in the future and should also make use of scientific information and concepts that are part of the course they are taking. After students understand the simulation techniques, they might be asked to design simulations, perhaps of a citizens' committee meeting, a meeting of the city council, or even a legislative subcommittee hearing.

In preparing the roles of the participants in the simulation, thought should be given to the kinds of people that might actually participate in the meeting being simulated. Roles should be as authentic as possible. Starting with a situation that requires only three or four roles makes it easier for both students and instructors to begin to use the technique.

Describe the situation to the entire class in sufficient detail so that each student understands the issue being addressed and the nature of the roles to be played. Ask students to volunteer for roles; some encouragement may be applied, but they should never be forced to participate. After students have become adept at simulations, some variations can be introduced. For example, they might be asked to play roles that are opposite to the views they actually hold, or students who are playing antagonistic roles might be asked to switch roles in the middle of a simulation.

During the simulation it is important for students to realize that if the going gets too rough, they may ask to terminate the simulation at any time. Instructors should be careful not to let situations degenerate into emotional tirades. The procedures already described for considering alternatives should be incorporated into the simulations so that students learn to think on their feet about ethical choices.

Much of the valuable learning experience from a simulation comes from the critique that should immediately follow each simulation. Role players might be asked their reaction to playing a particular role. They might also be asked what kind of preparation they did between the time they accepted a role and the time the simulation was held. Both the role players and the other members of the class might be asked if they got any new insights into the problem through the simulation, or how the simulation could have been made more realistic. A simulation should be considered successful if students gain a better understanding of the scientific concepts involved in the simulated situation and if they improve their ability to deal with ethical issues related to the situation.

Examples of a Classroom Activity

Values clarification, decision making, and simulation can be combined effectively to teach ethical decision making, as the following example illustrates.

In this simulation a group of individuals concerned with health care have gathered together to consider how the six-bed intensive care unit of the local community hospital will be managed in anticipation of a situation when more patients need intensive care than can be accommodated. The group consists of a physician from the intensive care unit; a nurse from the intensive care unit; a nurse from the general medical unit; the hospital administrator; a minister, priest, or rabbi; and a citizen concerned with health care. An observer-reporter sits in on the simulation. This person will listen to the discussion and report to the class the decision of the group, the main criteria the group used to arrive at their decision, and the factors they considered in arriving at their decision. Having an observer-reporter frees role-players to focus on the problem at hand.

In preparing for this simulation, inform the class of the situation and divide the class into groups of seven students each. A second citizen may be added to some of the groups so that all students in the class may participate. Explain the values clarification technique and the decision-making technique to the class and ask them to think about possible alternatives for dealing with the situation prior to the simulation.

At the time of the simulation, give each group a list of patients they are to assume presently occupy the six beds in the intensive care unit: (1) a young mother of two preschool children who is recovering from open heart surgery; (2) a seventy-five-year-old man whose emphysema requires the use of a respirator; (3) a middle aged businessman with lung cancer; (4) a sixty-year-old woman physician with congestive heart failure; (5) a teenager recovering from a motorcycle accident; and (6) a female welfare recipient whose husband has left her with three children and who is recovering from severe pneumonia. Two new patients need to be admitted to the intensive care unit. One is a brilliant student just entering law school who has been in an accident that caused head and chest injuries. The other is a middle aged teacher who is suffering from a particularly serious case of flu.

The primary business of the group is to devise a set of criteria for determining who shall be admitted to the intensive care unit. The group is expected to consider values involved and to reach a consensus on an ethically acceptable set of criteria. They may use the list of patients as specific examples of the kinds of problems that hospital personnel might encounter. They should test criteria by using them to decide which six of the eight patients would occupy beds in intensive care and how the other two would be cared for.

After the groups have reached consensus, the reporter for each group makes a presentation to the class. Variations in criteria and placement of patients may then be discussed. Especially important in the discussion is the quality of ethical decision making that is used by the groups.

Evaluation of Teaching and Learning

Students have much to gain from the use of the methods described here for teaching ethical decision making. Many students who are enrolled in introductory science courses are concerned about the effects of science on their lives. The consideration of ethical implications in science courses does much to provide a realistic picture of the effects of science on society. The techniques described in this chapter also provide students with methods for dealing with ethical dilemmas in a variety of circumstances they may encounter in the future. Knowing how to evaluate the ethical implications of a problem in science or in any other area makes for far better decision making than the irrational, emotional approaches that are sometimes applied to ethical problems. Finally, students are often more highly motivated to study science when simulations and challenging discussions are part of the classroom activities. In my experience, students who have passively occupied a back seat in the classroom seem to come to life when the participate in such activities.

Faculty members also benefit from the use of simulations and ethical decision-making techniques. Working with more highly motivated students is only part of the reward. To the extent that we want students to have positive images of science and scientists, using these techniques gives us an opportunity to show students that scientists are concerned about the effects of science on society. In the past, even those science instructors who saw the need for incorporating ethics into the teaching of science had few methods available to do this. Now that the methods described in this chapter and other similar ones are available, every science teacher can and should find a way to teach ethical decision making.

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Joan G. Creager is associate professor of biology at Northern Virginia Community College, Alexandria Campus and editor of American Biology Teacher. *She has served as a course director for the National Science Foundation-American Association for the Advancement of Science Chautaqua-Type Short Courses for College Teachers, where she offered a course on alternatives for science teaching.*

An instructional variable called wait-time *and a deliberate manipulation, the* pausing phenomenon, *can greatly affect student learning in the sciences.*

Pausing Principles and Their Effects on Reasoning in Science

Mary Budd Rowe

The particular research on science teaching described in this chapter has been carried out in a great variety of settings: college classrooms, museums, zoos, high schools, and in five different countries. If the results reported are employed, the nature and quality of student reasoning in science can be improved substantially. Moreover, the data from some of the investigations suggest that retention and later appropriate application of science in real settings can be increased. This chapter will summarize results of investigations with an instructional variable called *wait-time* and suggest how the reader might design and run an experiment to replicate the findings in his or her particular context. The deliberate manipulation of *pausing phenomena* and the effect on language and logic in science will be described in two different conditions: lectures; classroom discussions.

During lectures there are four kinds of mental lapses a dedicated student can experience. The more complex the content of the lecture or the newer the material is to the student, the more likely these lapses are to occur.

The first such lapse occurs when there is a context shift and the student fails to recognize it. This kind of problem is especially likely to happen in classes where mathematical or other abstract symbols are being used to represent variables. For example, a lecturer may be using *x*, *r*, and *t* to designate some variables at one stage in a lecture and later may employ these same letters in a changed context. The problem is that sometimes the student fails to grasp immediately that the context has shifted. This lag in context shift may only be a minute or two, but if the content of the lecture is difficult in relation to what the student knows, recovery and reentry into the instructor's chain of reasoning may be difficult.

If the lecturer introduces an idea which for some reason the student does not immediately grasp, there may be a second temporary lapse in attention to the ongoing flow of ideas. This kind of problem happens when the student experiences trouble connecting the content to what he or she already knows.

For knowledgeable students who may have been doing reading and talking out of class about a subject that comes up in lecture, a third kind of mental lapse can occur. The lecture content sets off an independent chain of thought on the part of the student—again, the interruption may be brief, but the lecture flows on and the student's task is to cycle back in.

Finally, a fourth lapse is common when a lecture is dense with content that is new and complex for the learner. The mind fatigues faster in these circumstances and responds to the situation by closing down for short periods.

These four lapses can be thought of as a random variable that fires off randomly throughout the lecture period. However, highly motivated students who are trying to understand the ideas being presented are more prone to lapses of the kinds described than are students who do not care. A treatment procedure called the *pausing principle* serves to improve the learning efficiency of these motivated students.

Pausing Principle

If a lecturer pauses for two minutes at least three times during a lecture and has students in adjacent seats share notes and comments, more of the content of the lecture will be learned and retained by more students. Typically, sharing by three students provides sufficient variety in the notes and interpretations of what was said to recover what each student might have lost. In addition, the immediate rehearsal of the ideas occasioned by the pause reinforces new concepts and decreases the chance that students will learn incorrect or partial concepts. Furthermore, the pause device forces students to use each other as resources.

During these analysis periods the students do not ask questions of the lecturer. The myth that one student's question is shared by almost everyone else in the class is rarely substantiated by research on the subject. These lapses instead occur far more randomly, if the class is taken as a frame of reference. The pausing period is not meant to interrupt or disrupt the flow of ideas in the lecture. Questions that are still unresolved in the groups are few and will be better treated at the end of the class. Systematic replication studies of the pausing principle in a wide variety of community college science classrooms and lectures need to be done because the variety of students and science topics taught in these classrooms is far greater than in universities. Our early results, however, indicate that when the pausing principle is applied in science lecture courses, students learn more, show better test performance, and retain more of the content three months later than if there are six minutes allowed for general questioning of the instructor or if the lecturer covers six more minutes of content.

Wait-Time

Another form of pausing called *wait-time* has relevance to college discussion sections. Research conducted by Rowe (1978) suggests that the typical rate of exchange between instructors and students is far too rapid. She found that teachers typically wait one second after they ask a question for students to begin an answer. If they do not start a reply in that period, the teacher either repeats the question or calls on another student. After the student responds, the instructor usually reacts within a second. There rarely is time for students to have second thoughts, to try alternate explanations, or to speculate about other possibilities.

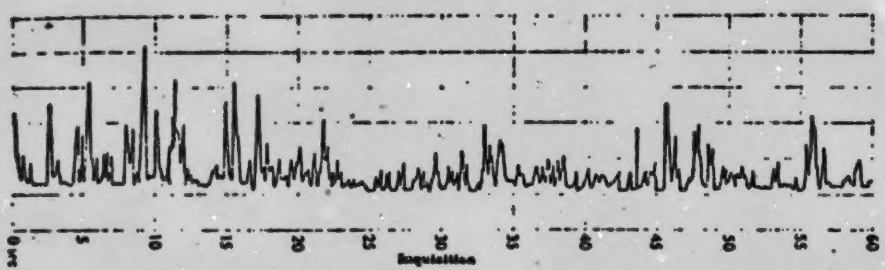
Analysis is made by feeding speech during discussion into a chart plotter; if there are pauses, the pen tracks horizontally. Figure 1 shows the usual fast interaction pattern, with no sustained pauses. When a person is trying to express a complex thought, however, his speech comes in bursts that are often separated by as much as several seconds. This is illustrated by the flat spots in Figure 2. The figure shows why rapid reaction hurts the quality of expressed thought: when the instructor responds immediately, the rest of the speech string gets cut off or attenuated. Recent samples of science section discussion rates in several colleges suggest the average wait-time is 1.2 seconds pause, with the pause after a student makes an initial response accounting for more of the variance in verbal behavior than the pause following the teacher's question (see Figure 3). Figures 1 and 2 illustrate why this might be.

If average wait-time durations of three seconds or longer are achieved six student language and logic performance variables that relate to science information processing in college classrooms change.

Length of Student Responses. Under a fast schedule, responses tend to consist of short pauses and rarely exhibit explanation of any complexity. Data from the chart plots suggest that when the second wait-time is prolonged, it contributes measurably to the appearance of longer statements. The average shift was from seven words to twenty-eight words.

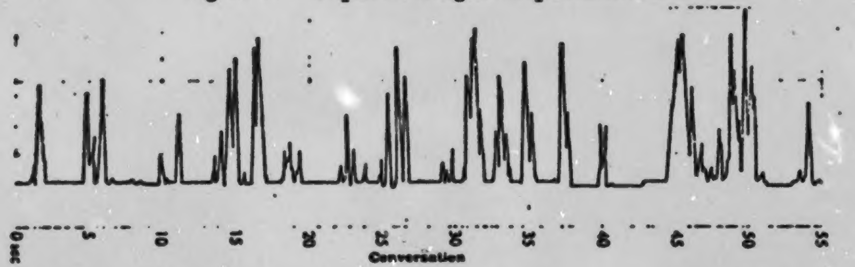
Unsolicited but Appropriate Student Responses. This outcome is more responsive to the second than the first wait-time but is influenced by both. The average shift was from a mean of three responses to a mean of thirty-seven responses.

Figure 1. Fast Interaction Pattern



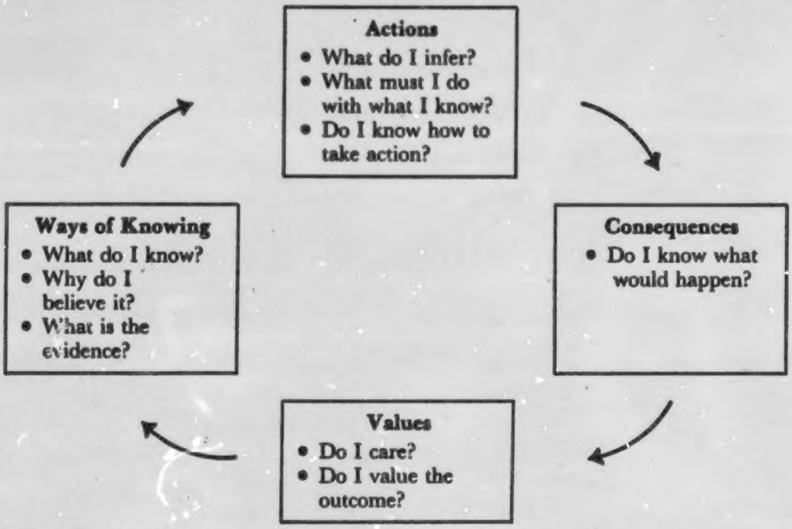
Source: Rowe, 1978

Figure 2. Complex Thoughts Expression Pattern



Source: Rowe, 1978

Figure 3. Features of a Discussion Cycle


Actions
• What do I infer?
• What must I do with what I know?
• Do I know how to take action?
Consequences
• Do I know what would happen?
Values
• Do I care?
• Do I value the outcome?
Ways of Knowing
• What do I know?
• Why do I believe it?
• What is the evidence?

Source: Rowe, 1974a, b.

Failures to Respond. "Don't know" or no responses were often as high as 30 percent in classrooms where the mean wait-time fell at one second or less. This outcome is more susceptible to manipulation of the first wait-time, the pause that the teacher allows before calling on another student or repeating a question. (It also happens to be responsive to reward incidence.)

Speculative Thinking. This is influenced by both types of wait-times. The average shift was from a mean of eleven events.

Evidence and Inference Statements. Under a fast schedule, the incidence of qualified inferences is extremely low. When wait-time is lengthened, this outcome variable changes in a desired direction and is more susceptible to the second kind of pause.

Number of Structuring Moves. It is a well-established fact from classroom interaction studies that students do not ask questions very often. When they do, the questions are usually for clarification of procedures and are rarely ever directed at other students. This outcome variable seems to be susceptible to both classes of wait-times. Structuring and soliciting moves by students shifted from a mean of 5 to a mean of 20, a four-fold increase. Moreover, it appears that duration of student attention and persistence in trying to incorporate these new ideas into their own conceptions of science increases.

It is no easy task to learn to manipulate the two pauses; in particular, the temptation to cut wait-time two short is overwhelming for some instructors. However, if one contrasts Figure 2 with Figure 1, it is possible to see why wait-time two is especially vital to the process. The flat spots are followed by additional speculation, clarification, and alternative explanation that never get a chance to take place without vigorous prodding under the inquisition model.

Ultimately the discussions may be guided through a cycle like the one shown in Figure 3. Apparently failure to go completely around the cycle in discussions leads to anomalies such as students who test well on knowledge but not on application or students who know that some principle is relevant to them but fail to incorporate appropriate actions.

Detection and Measurement of Wait-Time

To run a wait-time study you need a tape recorder and a stop watch (a chart plotter is nice but not essential). Make recordings of fifteen-minute time samples of discussions as you normally run them and find out what wait-time one and wait-time two averages you are generating.

Wait-time one types may appear in two varieties. Normally this type begins when the teacher stops speaking and terminates when a student responds or the teacher speaks again. If, as sometimes happens, a teacher asks a question, pauses, calls on a student, and pauses again, the two pauses are added together to constitute an instance of wait-time one.

Wait-time two is calculated by taking the sum of all pauses occurring on the student's part terminating when the teacher speaks. The more common varieties include the case in which a student speaks, stops, and the teacher speaks again; and the case in which a student speaks, pauses, speaks again, and the teacher rejoins the play. (Here the term student is used generically; that is, it refers to the two-player model. The pauses may occur within the speech of a single pupil or they may occur between the speech of a succession of pupils. In either case, the collection of pauses are summed and constitute a single instance of the post-student-response wait-time.) Correlations between the two kinds of wait-time vary somewhat but tend to be on the order of 0.17 (Rowe, 1974a).

Computation of Mean Wait-Time

How mean wait-time is calculated depends on the purpose to be served. One method is to calculate an unweighted mean by totalling the seconds for all pauses and then dividing by the number of between-player exchanges. This method is the one most easily understood by teachers.

A second method involves the calculation of a weighted mean. The sum of seconds for each kind of pause is divided by the total number of between-player exchanges for that type. This has the effect of weighting each type according to its frequency of occurrence. The mean of these two means is the average wait-time.

Student responses should be classified in a way that relates to those outcome variables appropriate to a given teacher. For example, evidence/inference connections among variables is of high interest in science. The teacher should tape a class, count the number of these connections in the fifteen-minute segment, and then figure the average length of each lecture in words or time units. The variables might be classified in this manner (Rowe, 1978):

- Verification Statements—questions that allow students to verify the contents of the system and the correct sequence of procedures.
- Evidence Statements—statements concerning condition of the system, statements of evidence of interaction in a system, observations.
- Analytical Statements—statements that identify variables and state relationships between them.
- Empirical Inferences—inferences that change variables or conditions and make predictions about the outcomes.
- Implication Statements—statements and questions in which students seek to explain relationships among variables.

This tape and analysis serves as a base line. In successive classes, the wait-time should be manipulated independently and jointly. The process should be treated like any science experiment: obtain data, perform analyses, alter the variables. For example, many instructors have a difficult time lengthening wait-time two. That sometimes can be cured when the teacher notices if he or she is mimicking or repeating things students say—an affliction of nearly 70 percent of all teachers (Rowe, 1978).

It takes knowledge of the discipline and a willingness to experiment with the pausing principle if one is to cycle completely around the phases shown in Figure 3. There are difficulties; for example, the discomfort and embarrassment that occur when you ask a question of a particular student and an answer does not seem forthcoming. A teacher must first be sure to give the minimum three seconds. Second, a ground rule should be established that a student may say: "I pass." Results of this option indicate that the student is 75 percent more likely to come back into the conversational flow without prompting before the period is out than if he or she either is not given sufficient time or does not have this option (Rowe, 1974a, b).

Discussion

It is at first counterintuitive to expect that a pausing phenomenon could produce the results described reliably and in settings as diverse as classrooms and the docent programs in the Smithsonian museum. Perhaps it is as Norwood Russell Hanson says: "The paradigm observer is not the man who sees and reports what all normal observers see and report, but the man who sees in familiar objects what no one else has seen before" (1972, p. 30).

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Mary Budd Rowe, a science educator, is director of research in science education at the National Science Foundation. She returns to the University of Florida in late 1980 as director of the Institute for the Development of Human Resources.

Results are reported from a nationwide survey of instructional practices used in science courses.

Teaching Practices in the Sciences

Jack Friedlander

In the fall of 1977 under a grant from the National Science Foundation, the Center for the Study of Community Colleges surveyed a national sample of faculty members who responded to a questionnaire concerning the instructional practices they were using in their science classes. Questions on this Science Instructor Survey Form concerned: course enrollment and completion rates; use of instructional techniques, media, and materials; reading requirements imposed on students; knowledge tested; items used on examinations; grading practices; use of out-of-class activities; use of instructional support services; suggestions for making the instructor's course better; and instructor characteristics.

The major findings of that survey are reported in this chapter. A more detailed account of the methodologies and findings related to science instruction, curriculum, and faculty characteristics (obtained in the larger study upon which this chapter is based) is available in the ERIC system. These monographs, edited by Florence B. Brawer, deal with the following subjects: agriculture and material resources (Beckwith, 1979a); anthropology and interdisciplinary social science (Beckwith, 1979b); biology (Edwards, 1979a); chemistry (Mooney, 1979a); earth and space science (Edwards, 1979b); economics (Friedlander, 1979a); engineering technologies (Friedlander, Rosenthal, and Edwards, 1979); interdisciplinary and environmental sciences (Edwards, 1979c); mathematics and computer science (Beckwith, 1979c); physics (Mooney, 1979b); psychology (Hill, 1979a); and sociology (Hill, 1979b). The principal findings of the survey of programs and course offerings are reported in Friedlander (1979b).

Course Enrollment and Completion Rates

The number of students enrolled in a class section influences the way a course is taught. For the total sample, analysis of course enrollment and completion rates showed that 79 percent of the thirty-two students who initially enrolled in a class completed it and received a grade. Students enrolled in science courses (defined here as agriculture, biology, chemistry, earth and space sciences, interdisciplinary natural sciences, and physics) were slightly more likely to complete their course (82 percent) than students in the behavioral sciences (81 percent) (defined here as anthropology and interdisciplinary social sciences, economics, psychology, and sociology) or engineering technologies (79 percent). The lowest completion rates occurred in mathematics (including computer sciences) where only 71 percent of the students received a grade.

Males were much more likely to enroll in engineering technology courses than females (89 percent versus 11 percent) and to a lesser extent in mathematics courses (59 percent versus 41 percent). A greater percentage of females than males were enrolled in behavioral science courses (56 percent versus 44 percent) and sciences courses (53 percent versus 47 percent).

Instructional Activities

Faculty members were asked to indicate whether or not they used each of twelve instructional modes in their classes. Most of the instructors used their own lectures (94 percent), quizzes/examinations (88 percent), and class discussions (81 percent). A much smaller percentage of the instructors reported that they used media (46 percent), lectures/demonstrations (29 percent), student verbal presentations (25 percent), guest lectures (12 percent), field trips (10 percent), and simulation/games (10 percent). Along with the findings on the percent of class time instructors devote to each of their instructional activities, the results noted earlier demonstrate that behavioral science and mathematics teachers still rely primarily on lecture and class discussion to present information to their students, while instructors in engineering technologies and sciences devote much of their class time to lectures and student laboratory exercises.

Instructional Media

One of the items on the Science Instructor Survey asked respondents to indicate whether or not they used each of fourteen forms of instructional media in their class. The three most popular types of media were charts/displays (56 percent), films (49 percent), and transparencies (47 percent). The other forms of media were used by less than 40 percent of the instructors. In all cases, a higher percentage of full-time than part-time faculty used the various instructional media considered. In terms of variety, science instructors were by far the largest media users, while those teaching mathematics introduced relatively few media in their classes.

Instructional Materials

Most of the instructors (95 percent) in the disciplines surveyed used a textbook in their course, while a substantially smaller number used one or more of the following materials: syllabi and handout materials (62 percent), laboratory materials and workbooks (44 percent), journals/magazines (25 percent), reference books (22 percent), collections of readings (14 percent), newspapers (11 percent), and problem books (10 percent). Over all, about 60 percent of the instructors indicated that they were very satisfied with their textbooks and their laboratory materials and workbooks; the others expressed some dissatisfaction with their instructional materials.

With respect to the selection of textbooks, 42 percent of the instructors noted that they had total say in this decision, 34 percent had to have their choice of textbook approved by either an administrator or a committee, and 22 percent had no input in the selection of their textbooks. Instructors in the sciences and behavioral sciences had the most say in the selection of their textbooks, while those teaching mathematics had the least. A much greater percentage of part-time than full-time faculty indicated that they did not participate in the selection of their textbooks (64 versus 13 percent).

Reading Requirements for Students

One of the questions asked of the faculty members was: "For your course, how many pages do you require your students to read in textbooks, lab manuals, collections of readings, reference books, magazines/journals, and newspapers?" On an average, instructors required their students to read 314 pages. The heaviest reading load was assigned by instructors in the behavioral sciences (419 pages). Science instructors asked their students to read more pages than did instructors in the engineering technologies (361 pages versus 235 pages), whereas instructors in mathematics courses gave their students the least material to read (205 pages). Textbooks accounted for most of the assigned pages in each of the disciplinary areas.

Knowledge Tested

Faculty members were asked to indicate the competencies they expected their students to exhibit on examinations. Close to 85 percent of the instructors in the sample noted that it was "very important" that their students demonstrate on their tests an acquaintance with the concepts of the discipline. Other competencies tested for on examinations included the following: mastery of a skill (51 percent); ability to synthesize course content (47 percent); understanding the significance of certain works, events, phenomena, and experiments (45 percent); recall of specific information (43 percent); and ability to relate concepts to students' own values (24 percent). Faculty members teaching a class in mathematics and engineering technologies were much more likely than those in the other disciplinary areas to emphasize mastery of skills on their tests. The ability to synthesize course content and to relate concepts to students' own values were stressed by instructors in the behavioral sciences and, to a lesser extent, in the sciences.

Examination Items

One half of the instructors said they frequently include multiple response items on their examinations. This type of item was most frequently used by instructors in the behavioral sciences (79 percent) and sciences (66 percent). A much smaller percentage in the total sample called upon their students to provide written answers to essay questions (31 percent) or completion items (25 percent). As might be expected, math problems were frequently used on exams in nearly all mathematics courses (93 percent) and most engineering courses (72 percent).

Grading Practices

Another survey item asked instructors to note their methods for determining students' grades and the relative weight assigned to each method in their grading. About 60 percent of the faculty used quick-score objective tests to determine a significant proportion of students' grades; essay exams were used by 41 percent. No other criterion determined a significant percentage of the students' grades. Other methods that were given at least some weight in the determination of student grades were homework assignments (40 percent), regular class attendance (35 percent), participation in class discussions (35 percent), papers written outside of class (34 percent), and laboratory reports (27 percent). In general, behavioral science instructors were more likely than instructors in engineering technologies and sciences to use written assignments (research reports, papers written outside and inside of class) in determining students' grades. Written assignments were not emphasized in most mathematics courses.

Use of Out-of-Class Activities

In addition to classroom activities and instructional materials, instructors were asked to note which, if any, out-of-class activities they required or recommended to their students. The list included on-campus educational films, other films, television programs, field trips, museum attendance, outside lectures, volunteer service, and tutoring. None of these activities were required by more than 5 percent of the faculty, although tutoring was recommended or required by 40 percent, outside lectures by 31 percent, and on-campus films by 30 percent. About 50 percent of the mathematics instructors and 40 percent of those teaching a science course recommended tutoring to their students. Full-time faculty were much more likely than part-time faculty to recommend that their students attend out-of-class events on the campus or in the community.

Use of Support Services

Just under 70 percent of the instructors in the sample received assistance from the colleges' clerical help. Media production/facilities assistance (38 percent), tutors (36 percent), library assistance (34 percent), and test-scoring facilities (25 percent) were also utilized by a considerable number of the faculty. Instructors in mathematics (51 percent) and science classes (37 percent) relied most heavily on tutors. Instructors in the behavioral sciences (50 percent) and sciences (46 percent) made the greatest use of the college's media production facilities. Laboratory assistants were used primarily in science (44 percent) and engineering technology classes (20 percent).

Working Conditions

One of the items on the survey instrument asked faculty members to indicate how their course could be improved. Over one half (53 percent) of the instructors answered that they needed students who were better able to handle the course material. The highest percentage of instructors who expressed a desire for better prepared students was in mathematics (55 percent), an area where over one third of the class sections were designed for students in developmental or remedial programs. The desire for better prepared students was lowest among the engineering technology instructors (46 percent).

Other changes desired by 25 percent or more of the faculty were the following: release time to develop course and/or course-related materials (38 percent), availability of more media or instructional materials (36 percent), stricter prerequisites for admission to class (31 percent), smaller classes (29 percent), and more professional development opportunities for instructors (25 percent). A much higher percentage of part-time than full-time faculty expressed the desire for more interaction with administrators and colleagues (28 percent versus 16 percent), and more freedom to choose materials for their course (20 percent versus 8 percent). A more thorough analysis of what changes instructors thought would make their course more effective is reported in Cohen and Friedlander (1980).

Faculty Characteristics

In 1977, 16 percent of the faculty surveyed were teaching part time. The highest concentrations of part-time instructors were in mathematics (28 percent) and in the behavioral sciences (21 percent); the lowest were in the sciences (15 percent) and engineering technologies (15 percent).

The largest percentage of the faculty had been teaching at a community college between five and ten years (38 percent). Only 4 percent had been teaching for less than one year, while 31 percent had been teaching for over ten years.

With respect to highest educational degree attained, most of the instructors held either a master's degree (77 percent) or a doctorate (15 percent). The highest proportion of faculty members holding a doctorate were in the sciences (23 percent) and behavioral sciences (17 percent). Instructors who reported that their highest degree earned was a baccalaureate ranged from a low of 4 percent among those in the behavioral sciences to a high of 29 percent in engineering technology. Only 8 percent of the total sample had not earned a degree beyond the baccalaureate.

Summary

The surveys of science education conducted by the Center for the Study of Community Colleges have provided much information about programs and courses that are offered in the sciences, classroom activities and instructional materials that are being used in science classes, and characteristics of the faculty members who are teaching science courses. We must now address the question of whether the science curriculum and the instructional methods used to present it are comprehensive enough to adequately meet the educational needs and objectives of students in each of the community colleges' constituency groups—transfer, occupational, developmental, general, and continuing education.

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Jack Friedlander is a staff member at the Center for the Study of Community Colleges and the ERIC Clearinghouse for Junior Colleges. He is currently working with Arthur M. Cohen and Florence B. Brawer on a National Science Foundation-supported study on the participation of women, minorities, and handicapped students in the sciences.

When attrition rates in many community college classes soar, modularized individualized study allows a larger percentage of students to achieve a degree of success.

Individualized Mathematics Instruction

Myrna L. Mitchell

The downtown campus of Pima Community College in Tucson, Arizona offers mathematics instruction in an individualized, self-paced format as an alternative to the traditional lecture-exam methodology. The Math Center, which involves four hundred to five hundred students and twenty to twenty-five staff members, provides a relaxed atmosphere for study and allows flexible scheduling of a student's required class attendance. Remedial and regular college-level studies are done side-by-side with no distinction in the treatment of the students, thus removing the stigma of remediation. Tutorial assistance for students of lecture classes and some test-proctoring services for classroom instructors are incorporated into the same program as a means of providing instructional support with little additional staff or facilities needed.

Operation of the Program

Staff Organization. One faculty member is designated as lead faculty or Math Center coordinator and has numerous responsibilities: hiring and scheduling instructors, assistants, and tutors; training and supervising staff; establishing procedures and record-keeping systems; maintaining records; developing curriculum; preparing study, supplementary, and audiovisual materials; assigning special assistance to students as needed; determining grades; and serving as the instructor on duty several hours each week.

Other instructors, fully certified at the community college level, serve as teachers during instructional hours. They work directly with students, answering questions and guiding them in individual study. They also guide the tutors in doing the same, as well as distribute materials, grade students' tests and quizzes, and assign prescriptive work for students as the need is indicated.

One person is a clerical assistant with responsibility for recording grades, verifying student registrations, maintaining tutor work-time records, maintaining supplies, contacting absentees, tutoring students as time allows, and assisting the lead faculty.

Peer tutors are responsible for the majority of the personal contact with students. They answer students' questions and explain mathematical concepts and operations, distribute study materials and evaluative items, and assist with clerical tasks.

At Pima, the Math, Reading, and Writing Centers, together with testing/tutorial services, comprise the Alternative Learning Center (ALC). Lead faculty of each subject area work with the ALC coordinator to facilitate the operation of the ALC as an entity. A paraprofessional manages the testing program, which provides free diagnostic testing for academic counseling, and tutorial services for subjects other than math, reading, and writing.

Course Offerings. The remedial courses offered are arithmetic and beginning algebra. Technical Mathematics I and II, including arithmetic, geometry, algebra, and numerical trigonometry, are offered to meet the math requirements for the student in a technical/vocational program such as air conditioning or automotive maintenance. University transfer courses offered are intermediate and college algebra and trigonometry. Each course, originally a three-credit course, is modularized into one-credit segments in order to allow for student pacing. Some students complete only one credit in a semester; others complete as many as six credits.

Registration. A student registers for individualized study through the regular registration procedures, with each module listed as a separate class. Most register initially for all three modules of a course, unless known learning difficulties or time constraints are involved. After the first experience the student is better able to select the appropriate load. Withdrawal from or addition of modules may be done at almost any time during a semester.

Student Attendance, Scheduling, and Orientation. Since the Math Center serves as a tutorial center and an individualized study center, a distinction is made between instructional and tutorial times. This distinction applies only to students registered for individualized study, since tutorial assistance is available to all students at any time the center is open. Instructional hours are those when an instructor is on duty as well as tutors; during tutorial times, the center is staffed only with tutors. Students are required to study in the Math Center one instructional hour per week for each credit of registration; they are not penalized in grades for not attending, but they are expected to make up absences by attending extra instructional hours.

Students are urged to visit the Math Center as soon as possible after registration. They select the required number of instructional hours at their choice of times in half-hour intervals, subject to a maximum of twenty-five students at any given time. Scheduling is handled by computer on a first-come, first-served basis. Instructional hours are generally 8 A.M. to 3 P.M. and 5 to 9 P.M. (shortened on Fridays), but vary from semester to semester.

All students are shown a brief slide-cassette orientation program on the first visit. The operation of individualized study is explained. Pictures of the faculty and some of the tutors are shown, and the student is informed of his responsibilities and what he may expect from the staff.

Study Procedures and Evaluation. Each student is given a study guide that includes an outline of the course, assignments, objectives, an errata sheet for the text, notes or material to supplement the text, and a listing of available audiovisual materials. Most class time is spent reading assignments or working problems. However, students are urged to work on assignments outside of class, just as students in lecture classes are expected to do. Then, during class times, they are ready to ask questions about any material that needs clarifying or about problems that they could not solve. Audiovisuals may be used during class time, and tests or quizzes may be taken.

If a student has considerable difficulty, a tutor may be assigned to work with him or her at length on a one-to-one basis. Appropriate supplementary exercises may be assigned, or models and audiovisual materials may be used in an attempt to overcome the difficulties.

Each module is subdivided into at least two units. When a student completes the assignments for a unit, he or she is given an open-book quiz intended primarily as a learning tool. Generally no partial credit is given in scoring a quiz. If the grade is below 70 percent, the student reviews the material, takes an alternate form of the quiz on a later date, and repeats the process until he or she achieves at least 70 percent mastery. A bank of four forms of each evaluative item has proved adequate, with only an occasional student needing a fourth form.

After all unit quizzes for a module have been passed, the student reviews for a closed-book cumulative test by using those quizzes, which are retained in the Math Center. Tests are scored only by an instructor and partial credit may be given. A minimum mastery level of 70 percent is expected, and each retake results in an additional 5 percent reduction in the earned score.

The student's grade for a module is determined from the quizzes and tests. The quiz average is one fourth of the grade; the test score is the other three fourths. Grades are determined on the following scale:

A—90 to 100
B—80 to 89
C—70 to 79
NC—0 to 69 (NC = No Credit)

A separate grade is given for each module. If a student completes all three modules of a course in one semester, the three module scores will be averaged if it is to the student's advantage. Additionally, the student may choose to take a comprehensive final exam on the three modules. The lowest score of the final and the three module scores would then be dropped for the grade determination.

Fluidity of the Program. Self-paced, individualized study lends itself to an open-door policy. A student may register and begin study or add another module to his or her current registration at almost any time. The college encourages this by not charging late registration or schedule-change fees. Open exit is not a reality yet. Students may also complete work at any time during the semester. Their records are then transferred to the "completed" file, and they do not attend class for the remainder of the semester. Many students who finish early register for another module.

There are two options available to students who do not complete all modules for which they register by the end of the semester. The preferred method, from the viewpoint of the staff, is for students to withdraw from all modules that they have not completed. They may reregister for those modules at any time within one year, and all completed evaluative items will be transferred to the new records, allowing continuation rather than repetition of their studies.

Under some circumstances, withdrawal and reregistration create a financial hardship for the student. Then, if the student has met attendance requirements and has successfully completed part of the module, a grade of "I"—incomplete—is given. Administratively, "I" grades are avoided if possible due to the paper work involved, the funding situation, and the fact that few students receiving "I's" ever finish their studies.

Individualized study is only an alternative to the lecture class. Some students discover that they need or prefer the structure of a formal class. The same textbooks are used in both modes of study, facilitating transfer of a student from one mode to the other. Seldom has a student changed from individualized study to lecture class, partially because the student falls behind schedule before he or she realizes he would prefer the lecture class. Many students, however, transfer from the lecture class to individualized study of the same course. The prime reason for such a transfer early in the semester is for acceleration of their studies. Later in the semester, it is due to their falling behind: they may drop the three-credit class that they could not finish and salvage one or two credits by registering for individualized study.

Statistics of the Pima Program

Individualized study has proven to be popular with the students. Enrollment has risen from sixty-nine student in the spring of 1975, before the three-credit courses were modularized, to 475 students in the fall of 1979.

Success rates for individualized study, figured as the ratio of single-credit successes to total credits of registration, are just a few percentage points lower than the lecture class success rates for the same courses, in spite of self-pacing—both are slightly below 50 percent. However, 66 percent of the students in individualized study have success in at least one module.

Approximately one third of the students registering for individualized study totally withdraw from the course before the end of the semester. Other students partially withdraw. The overall withdrawal rate may approach 40 percent. This may seem high, but students are encouraged to withdraw from any modules that they will not complete.

The tutorial services are used by lecture class students on a "drop-in" basis. In the fall 1979 semester, there was an average of more than seventy visits per week for tutoring in any of the math courses offered on the campus, as well as some of the physics and chemistry courses.

Problems and Recommendations

Many problems regarding staff, compensation, and facilities have been experienced in the program. Some have been overcome, and there are tentative plans for attacking others.

Dependence on Student Aides. From its inception, the Math Center has depended primarily, if not totally, on student aides for its tutors. Federal College Work Study (FCWS) guidelines will not authorize an FCWS aide to work prior to the first day or after the last day of class. The college extends that policy to the regular (college-funded) student aides. Still, it is vital to orient student aides to procedures, policies, and materials before the first student attends class. This has been addressed by a two-day workshop for the aides the week before classes begin, with the aides' wages being funded from an "other compensations" category.

Since it is difficult to find students attending Pima who are qualified to tutor the highest level of math courses offered here, some persons who are not Pima students are hired as instructional aides. The primary source for this category of personnel is the University of Arizona math or engineering student body.

Tutor scheduling is also a problem—one that is unlikely to be solved as long as peer tutors are themselves students working at minimum wage. Their classes tend to be at prime class times, which is exactly when the Math Center has its peak attendance and needs the largest number of staff. It is extremely difficult as well—in some semesters totally impossible—to find an hour when all of the tutors can meet for training, due to their own class schedules.

Inadequate Facilities. Growth has been so rapid that facilities have not kept pace with enrollments. The original Math Center was a part of one large room shared by the Math, Reading, and Writing centers, the ALC coordinator's office and telephone, the secretary's typewriter, and two noisy computer terminals. The new facility, opened two years ago, provides separate areas for each center.

The Math Center has a capacity of approximately twenty-five students, an office area, a testing room with seven student stations, and a small office for the lead faculty. Three student stations are carrels equipped with audiovisual equipment; another is equipped with a Digitor for practice on basic arithmetic facts. All audiovisual materials were intended to be housed in the Media Room, but that was found to be unsuitable since no math staff was present to answer questions. There is a great need for a workroom to house the typewriter, telephone, and computer terminal, and for an eight-to-ten-student classroom for spontaneous small group discussions or for minilectures on particular topics such as prime factorization or word problems. With larger facilities and slightly increased tutoring staff, the student-instructor ratio could be increased, making the program more cost effective.

This problem is augmented by an early ALC policy that each subject area was to be treated exactly the same. The Math Center is still suffering from the effects of that policy. Obviously it requires more effort and more financial support to maintain a program with 475 students in seven courses than one with 250 students in four courses; yet the staff, budgets, and facilities have been very nearly the same.

Faculty Loading and Scheduling. Each full-time member of the math faculty spends some time as the instructor on duty in the individualized study program. The remainder of the instructional hours are staffed by part-time or associate faculty. Scheduling the full-time faculty to avoid conflict with their other classes is very difficult, and class cancellations always cause last-minute changes.

The individualized study program in math was originally called the "Math Lab." At Pima faculty loading for lab classes was figured at 0.7 load hour per clock hour. It became obvious that the lead faculty worked every bit as much as classroom instructors. The administration agreed to a change. The lead faculty was granted one load hour for one fifty-minute period, sixteen periods for a full load. All other faculty continued to receive 0.7 load hour, but for a fifty-minute period. This compensated somewhat for the difference in responsibility between the lead faculty and the other instructors.

Despite these changes, the most recent faculty contract at PCC specifically states that instructors of self-paced classes be paid one load hour for one fifty-minute period. The lead faculty have lost the edge in compensation but still have the burden of responsibilities. A small additional compensation has been arranged. The raise in loading was a costly mistake and one that should be avoided in implementing such a program.

Recommendations for Staff Organization. I feel that an individualized study program such as this one needs a full-time administrator by the time student enrollment nears 400. Presently the lead faculty serves as instructor on duty thirteen hours each week yet does very little actual instruction due to administrative duties. The following recommendation for staffing is made:

- A full-time Math Center Coordinator, who would have all the duties described above for the lead faculty, except no instructional duty.

- Two or three paraprofessionals, bachelor's degree level, community college certification not required, to serve as instructors.
- Two clerical assistants, associate or bachelor's level, one full-time, one half-time, to provide full day and evening coverage.
- Peer tutors, not necessarily students at the same or any institution, one tutor for every twenty-five to thirty students.

This recommendation is based on a program of 400 to 500 students and the numbers may vary for different enrollments.

Special Services. Some students need special help with their studies due to mental or physical disabilities. The self-paced study offered in the Alternative Learning Center provides some of the personalized assistance offered by the special services department on other campuses. A program that does not provide this special service would not require as many tutors as recommended above.

Evolution of the Pima Program. The Math Center began in the fall of 1974, with one student aide available a few hours each week to tutor students enrolled in math classes. The next two semesters the center offered individual study in six three-credit courses—all of the present courses except trigonometry. It was staffed by two part-time faculty and some student aides as tutors. No evening hours were planned until an evening class was cancelled due to low enrollment, and the class and instructor were transferred to the Math Center. Whenever classes were cancelled due to low enrollment, the students were encouraged to enroll in the individualized study courses.

It was clear to the administration that full-time leadership was needed in the Math Center. In January 1976, I became the lead faculty, with full daytime instructional responsibility as well as lead faculty duties. A part-time instructor covered the evening hours. As the faculty loading was adjusted, more part-time faculty were involved in the instructional aspect of the program.

Neither study nor evaluative materials were prepared when the individual study program was first offered. Some commercially prepared audiovisual materials had been purchased. By the end of the first year, only a couple of tests for each three-credit course had been prepared. Courses had not been modularized into single-credit offerings. If the student failed the test, he or she failed the course. There were no alternate forms or retake options and no unit quizzes.

At this point the full-time lead faculty was hired. Priority was placed on the preparation of an assignment sheet for each course, followed by unit quizzes. With six courses and approximately nine units per course, considerable time was involved in the preparation of just one form of each quiz.

Gradually the bank of evaluative items has been expanded to four forms of each quiz and test. The assignment sheet has grown into a study guide including much more than just assignments. A file of supplementary exercise materials has been prepared, some models and puzzles have been purchased or constructed, and a few slide-tape shows have been prepared to meet the students' needs.

The lead faculty soon realized that the "student-paced study" being offered was not truly student paced. Grades could be given only on complete three-credit courses. The lead faculty felt that a student who worked faithfully the entire semester yet progressed slowly should not receive a grade of "NC." These students were instead given "I's" and there were many. In succeeding semesters these students used the Math Center services, though they were not registered and were not counted in the basis for staffing (this was the motivation for modularizing all the courses). The number of "I's" given in a semester has been reduced to one fourth of the previous levels.

As the program grew in staff and students, it became necessary to establish policies regarding late admissions, student attendance, grading standards, calculator usage, and tutor absences and tardies. Currently the Pima program has a lead faculty, seven other instructors, one assistant, and twelve to fifteen tutors. The lead faculty, instructors, and assistant discuss and set the policies, with the lead faculty making the final decision if consensus is not reached.

Many aspects of the record-keeping systems are determined by the same persons, with the assistant perhaps having the chief responsibility. At first, student attendance was not monitored. Currently each student uses an attendance card that is kept in the Math Center. Each color-coded card identifies courses and modules the student is studying and provides a chart of attendance showing actual times, a record of which evaluative items have been attempted and which passed, a record of instructor-conference dates (three conferences per semester are encouraged), and room for brief notes to the student. Each student's tests and quizzes are kept in a folder, labeled with the same color as the card, and each course has a record sheet, specially prepared for grade computation, that is included in the folder.

Conclusion

The individualized study program in mathematics at Pima has proved to be a viable alternative to the traditional lecture-exam classes. No claims are made of having found a panacea for mathematics instruction. However, this type of program can be as cost effective as the traditional classroom approach and can provide some degree of success to a larger percentage of students.

Myrna L. Mitchell is the developer of the individualized study program in mathematics at the downtown campus of Pima Community College in Tucson, Arizona. She has been lead faculty since spring 1976, after serving as part-time faculty for PCC since fall 1974. Interest and direction in the program development came as a result of attendance at the Rocky Mountain Mathematics Consortium, University of Arizona, spring 1976.

For many of us, teaching sociology at the community colleges is at once a source of enduring excitement and a source of gnawing frustration. How could it be otherwise? We are teaching one of the broadest subjects to one of the most diverse student populations in higher education.

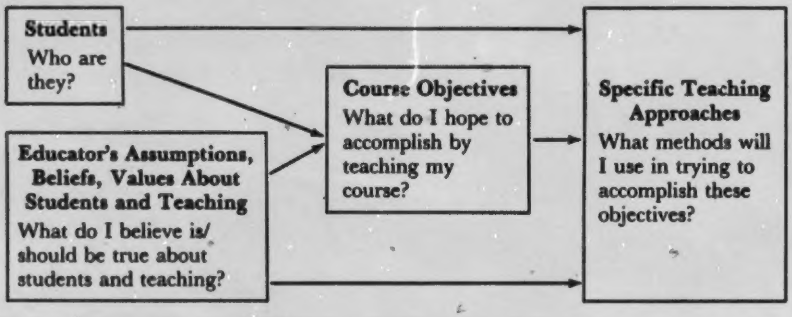
Teaching Sociology in the Community College

S. Y. Bradford

A sizeable body of data has been gathered on demographic characteristics and trends in community college student populations. Making an inferential leap from some of these data, we could describe a prototypical community college class as being heterogeneous on several dimensions. It might contain students ranging in age from seventeen to seventy, with the bulk of day students being young adults and the evening students being somewhat older. Depending on the population makeup of the local community, the class might be multiracial and multiethnic and might include several social classes. One third to two thirds of the class members are employed part or full time. Few members of the class plan to major in sociology, although some may be training for related fields. And the students are attending college, as well as taking a sociology course, for a variety of reasons. In a recent California study (Hunter and Sheldon, 1979), students were asked to state their main reason for coming to the community college. About one third mentioned preparation for transfer, another third named preemployment training as their goal, and about one fifth (who, according to the researchers, may have included some of the undecideds) mentioned self-enrichment. Additionally, these students of varying age, race, ethnicity, economic background, and motivation are widely variant in their academic preparation.

Faced with such diversity, how can a sociology instructor determine, much less address, the needs of his or her students? One possible way of con-

Figure 1. A Model for Teaching Sociology


Students
Who are they?
Educator's Assumptions, Beliefs, Values About Students and Teaching
What do I believe is/should be true about students and teaching?
Course Objectives
What do I hope to accomplish by teaching my course?
Specific Teaching Approaches
What methods will I use in trying to accomplish these objectives?

ceptualizing this issue is shown in Figure 1. In short, what we *know* to be true about our students and what we *believe* is or should be true about them and about teaching are the motivating forces behind what we ultimately do in the classroom, whether or not we make those assumptions and values explicit to ourselves or others.

Assumptions and Values

My ideas about teaching sociology in the community college are based on familiarity with the demographic characteristics previously mentioned, as well as several beliefs, assumptions, and values regarding students and teaching. My reason for listing them is not to assert that they are the "right" values and beliefs but rather to shed light on the ensuing descriptions of course objectives and teaching approaches.

1. An overarching educational goal is to affect (inform, advise, motivate) as many students as possible.
2. There is more than one style of learning—an educator cannot always easily monitor or measure the various kinds of learnings that might be taking place in the classroom.
3. Many students are enrolled in sociology courses, not necessarily because they believe the subject matter to be intrinsically interesting (as do most instructors), but because the course fulfills a school or program requirement.
4. Many students are minimally familiar with the college setting and with some of the survival skills that can contribute to their academic success. Exposure to some of these skills can be integrated into a sociology class.
5. Community college students, as adults, are not blank slates upon which the instructor writes volumes of "knowledge" or "wisdom."
6. Given their diversity in age, background, and so forth, students can learn a great deal of subject-relevant information from each other.

7. Students studying human interaction should interact with each other within the context of the course.
8. Exploration of the "self" or the affective domain (one's feelings, values, opinions) is not only legitimate but especially relevant to behavioral science curricula.
9. Ethical neutrality is not genuinely possible. However, my primary goal is to teach students *how*, not what, to think, and to familiarize them with some of the major social issues of our times.

Based on the aforementioned values, beliefs, and student demographics, my sociology curricula are built around four general types of course objectives.

Subject Matter

This category of objectives, which involves introducing students to the fundamental concepts and methodology of the discipline, is, no doubt, almost universally shared by sociology instructors. The diversity of students' backgrounds, academic preparation, and learning styles warrants the use of *several* teaching modalities to impart subject matter, including the didactic method (lectures), audiovisual presentations (films, tapes, charts, and so forth), content-centered class discussions (entire class or small group), and in-class structured experiences. Exclusive use of any one of these approaches, lecturing included, is much less effective than a judicious blend of all of them. The exact blending will vary depending on the course content and personal preferences of the instructor. The following suggestions should be considered, however, regarding the use of nondidactic approaches:

1. Films, speakers, and structured exercises can be most educational when dovetailed with a specific content area being addressed in lectures and reading assignments *and* when a discussion (instructor's comments, class reactions, or both) follows such events. Advance planning is essential for the most effective use of nondidactic methods.

2. Unstructured class discussion is generally counterproductive. The instructor can introduce some structure by acting as a discussion facilitator (which does not necessarily mean doing most of the talking) or by providing guidelines or suggestions for discussion (for example, a set of questions given to small groups, with one or more members acting as a recorder of group ideas).

3. In-class structured experiences (role plays, simulations, demonstrations, and so forth) should be carefully selected and not overused. Some important criteria to consider are: the amount of advance preparation, materials, and class time needed; the content area(s) to which the experience is related and the specific learnings to be induced or deduced; and the level of trust and openness between students or between teacher and students that the exercise requires. (For most adults, experiences that are highly psychologically threatening tend to block rather than facilitate learning.) The use of multiple

teaching approaches can not only enhance the class' interest level but can also take into account the diverse needs of class members.

Survival Skills

This set of objectives is similar to what Fantini calls "learning-to-learn skills" (Fantini and Weinstein, 1968, p. 30). In this context, "survival" primarily implies survival in school. Many people attending community colleges are seriously deficient in certain "how to" skills that are essential to their academic success. Certain skills can be taught that are particularly relevant to sociology or that might enhance student's college performance in general, such as taking adequate lecture notes, reading tables and graphs, understanding and using simple descriptive statistics, and so on. Some examples of specific survival skills which could be integrated into an introductory sociology course are listed in Table 1.

Social Reality Awareness

I use this phrase to represent something similar to Mills's phrase "sociological imagination" (Mills, 1959) and to subsume Freire's phrase "critical consciousness" (Freire, 1970). This category of course objectives involves encouraging students to think critically about human behavior and the nature of society. Perhaps more than any other academic discipline, sociology has the potential to increase students' awareness of the world beyond their personal worlds, awareness of how social-psychological and social-structural variables impinge upon their own and others' lives, and awareness of the sources and nature of social injustice.

Self-Awareness/Self-Esteem

This set of objectives represents one cornerstone of the philosophies of humanistic or confluent education (Brown, 1971). These philosophies emphasize the legitimacy and necessity of attending to *affective* learning in addition to cognitive learning, as opposed to a solely cognitive-based curriculum. Opportunities for affective learning are probably more available and appropriate in the behavioral sciences than in any other area. Instructors can consciously construct their course in such a way that students have opportunities for values clarification, self-insight, and self-expression. It is perhaps in this area of personal growth that the academic catchword of the 1960s and 1970s, "relevancy," has its quintessential meaning. Lectures, class discussions, structured experiences, and so forth can be selected and adapted for the purpose of teaching cognitive subject matter while at the same time providing opportunities from which students might learn some new things about themselves. Likewise, course assignments can request students to examine their own values, atti-

Table 1. Developing Survival Skills

Skill	*Learning Experience*
Note taking	1. Mini-lecture on note taking (for example, how to identify professors' cues, the use of abbreviations, and so forth). 2. Instructor then asks students to take notes from a record or tape and subsequently checks them or lets them examine each other's notes. 3. Using an overhead projector, the instructor and the class simultaneously take notes from a taped lecture or from the mini-lecture itself.
Taking an Exam	1. Instructor goes over first exam in class pointing out test-taking strategies or allowing "successful" test takers to share their strategies with classmates.
Basic Statistics	1. Lecture on statistics/data gathering. 2. Instructor gathers data on the class through questionnaires. Then, in small groups, students find the class means, percents, and so forth. 3. Individually or in small groups students write their own questionnaires to be administered on or off campus and then analyze the data.
Reading a Table/Graph	1. Mini-lecture on reading tables/graphs. 2. Individually or in small groups students interpret selected tables related to a topic under study or convert raw data into table or graph form.
Detecting Propaganda (including "lying" with statistics)	1. Lecture on propaganda techniques. 2. Alone or in groups, students write their own examples of various propaganda techniques. 3. Students collect propaganda examples from mass media.
Preparing for demands of four-year institutions	1. Instructor invites a former student who has transferred to a four-year college or university to describe to the class what the change is like.

tudes, and behavior with regard to specific ideas and experiences connected with the course.

Small Group Experience

In the years that I have been teaching in community colleges, I have been struck by the enormous difference in classroom atmosphere between a small class (fifteen to twenty-five students) and a large class (twenty-five to forty-five students). A much greater degree of informality and closeness develops in the smaller classes; even the shy people become more open as the weeks go by. Of course, the reasons for this difference are fairly obvious. A large group in and of itself seems to have an inhibiting effect on many individuals who, when placed in a more personal context, feel less threatened or inhibited and become more open and communicative.

Breaking up a large class into small groups for discussion or structured experiences tends to increase informality and participation; nevertheless, the overall extent of student isolation at the end of the term may be only slightly less than it was at the beginning when we were almost all strangers to each other.

However, students' membership in a continuing small group of five to seven people can facilitate peer learning as well as class informality. Either the instructor or the class can decide the basis upon which groups will be formed (random grouping, joining with people who are different in terms of age or ethnicity, and so on), or the instructor can allocate a brief period of time for acquaintance exercises prior to forming groups. The rationale for this arrangement is that students' membership in a "permanent" group within the larger class can be a vehicle for several learning experiences.

Learning About Sociology. Students can act as peer teachers, clarifying sociological concepts and theories that are discussed in lectures and reading assignments. They can also gain some insights into human interaction and group functioning by observing the behavior patterns that emerge within their own group. After a certain degree of *esprit de corps* has developed, it is possible to engage the various groups in interaction with each other that might provide insights into intergroup and intragroup behavior.

Learning About Self. Group discussions and exercises provide students with opportunities to compare and contrast others' backgrounds and attitudes with their own. And within the group, the individual can begin to monitor his or her own reactions to other group members' comments or behavior.

Decreasing Impersonality and Isolationism. Membership in an ongoing group gives each student a core of acquaintances within the rather anonymous and loosely knit larger class—students with whom the individual may feel safe to ask information and perhaps with whom he or she will form alliances outside the class.

Of course, there is no guarantee that this or any other outcome will take place. Overall, however, given student feedback and my own observations, I am confident that the small group experience has substantial utility in a community college sociology class in which the instructor wants to encourage class participation, peer learning, and an informal atmosphere.

Conclusion

No course can be everything to everybody. But all courses can and should be informative and stimulating to students and teachers alike. They can and should make demands of students while in some way taking into account the diversity of students' academic preparation, backgrounds, and learning styles. Our responsibility as educators is to ascertain and meet the educational needs of as many of our community college students as possible. That is a tremendous challenge that may require nothing short of a major institutional restructuring of our community colleges. But the challenge is now. The classroom is the place to begin.

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S. Y. Bradford formerly taught at several northern California community colleges. She is now an assistant professor of sociology at Los Angeles City College and is pursuing a Ph.D. degree in Education at the University of California, Santa Barbara.

At one community college placement testing has had a dramatic effect in reducing failure in mathematics courses for incoming students.

Mathematics Placement Testing

June P. Wood

It is common to assume that a first course in mathematics for a college freshman should be college algebra, if not a higher one. Today, in many colleges that assumption is unwarranted. Despite the current emphasis on mathematics in both elementary and secondary schools, modern high schools still offer varying routes to a diploma, not all of which prepare a student for college entrance. But a diploma from an accredited high school, however acquired, remains a sufficient condition for entrance in many colleges, particularly junior colleges. Colleges with an open-door policy are therefore faced with ever-larger numbers of entering freshmen who have studied very little or no mathematics.

The fact that many junior college freshmen have insufficient backgrounds for college-level mathematics became evident at South Texas Junior College, now the University of Houston Downtown Campus (UHDC), by the unusually high level of failures and withdrawals in the college algebra course; indeed, the "mortality" rate (all "F's," "WF's," and "W's") in college algebra was over 50 percent. Furthermore, many of the students who failed or withdrew had repeatedly failed or withdrawn from this same basic course.

These statistics are not meant to imply that junior college students are chronically inept in mathematics. An analysis of some 3,000 high school and college records made by our department members in the spring and summer of 1966 revealed three probable causes for failures among entering freshmen:

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- Half of the freshman class had not completed two years of high school algebra. Many of this group had completed at most two semesters; some had taken none at all.
- Another sizeable group (about 15 percent) had completed two years of high school algebra but had been out of school for three, four, or more years. Because of this period between graduation from high school and matriculation in college, they had apparently forgotten many skills they had learned in basic algebra.
- A third group of failures consisted of students who had two credits in high school algebra and had not been subject to a significant time lapse between high school and college; however, their two credits were based on minimal grades: "C's" and a preponderance of "D's." This minimum-grade group obviously included students with little ability, but it also included able students whose sense of purpose and interest in education had matured from their sixteen-year-old view of the matter in tenth grade.

The department staff estimated that 60 percent of our junior college freshmen were inadequately prepared for college algebra. Recent and more accurate methods of screening freshman mathematics students have shown that 80 percent might be a more accurate estimate.

Review Course as Solution

As a means of minimizing the waste of students' time, effort, and money, the department of mathematics recommended institution of a one-semester course that was to include an intensive and accelerated review of high school algebra. Cutoff scores for this review course and the college algebra course were determined by the American College Testing (ACT) test scores (a score of 420 in math). Students who scored below these levels were put into the review course. The percentage of failures in college algebra declined, but the cutoff scores proved unreliable as a measure of acquired algebraic skills. Students with scores above cutoff levels still failed college algebra for lack of background knowledge. A contributing factor may be that SAT stands for Scholastic Aptitude Test, not Scholastic Ambition Test. There is no defense against the resolute underachiever.

For these reasons the mathematics faculty has devised a forty-five- to fifty-minute placement test. The skills tested represent the minimal knowledge required for the student to have a reasonable chance for success in college algebra; they do not include all the topics covered in the review course. This test (now expanded somewhat) is given continuously throughout every registration period. All students wishing to enroll in either college algebra or trigonometry are required to report first to a designated testing center. This center, staffed by the mathematics faculty, provides instant evaluation, placement, and appropriate course-approval slips that have become a regular feature of registration. Students who obtain a raw score below 70 on a scale of 0 to 100 are required to take the condensed review course. In order to encourage the study of mathematics, the college gives elective credit for the course. Transfer credit varies with different senior colleges: some give mathematics credit; some give elective credit; some give no credit.

After the first year of this one-semester review course (from fall 1966 to fall 1967), the mortality rate in the college algebra course was cut in half: from 56 percent to 28 percent. We learned from the placement test that the mathematical background of a junior college freshman is a variable the range of which is wide enough to include anything from a need for arithmetic to a readiness for calculus.

However, wide as that range may be, its elements cluster densely about the "need for arithmetic" point. This fact was dramatically demonstrated at our college in the summer of 1967. In August of that year, an early registration period for the fall semester was set up for a special group of 625 entering freshmen, all just graduated from high school. The placement test was administered to this group, and special records for these students were kept. Out of those 625 students, only forty scored above 70 on the placement exam. Five hundred eighty-five students were not prepared for any sort of college mathematics.

The 1140 students enrolled in the review course that fall included 203 students from the special early-registration group. We administered as an experiment exactly the same placement test to these same 203 students in the twelfth week of that fall semester. The results were startling and revealing. Individually they ran from triumph to disaster. Our records show that 96.6 percent of these 203 students scored higher the second time they took the test; the grades of the remaining 3.4 percent stayed exactly where they started—at zero. Happily, the triumphs exceeded the disasters. The great improvement shown by the majority of the students is best confirmed by the median grade of the scores made on the two tests. In the August test, the median score of the 203 students was 7; in the twelfth week of the fall semester, the median score of these students on the same test was 74.

Our condensed and accelerated review course in algebra had clearly improved the freshman mathematical climate. However, a mortality rate of 28 percent in a course in college algebra taught in our small classes to students screened by placement tests and/or review courses was hardly laudable. Furthermore, while a one-semester review course is certainly better than none at all for unprepared students, it is still a crowded, pressured, and incomplete preparation for students with little or no algebraic background. To teach two full years of high school algebra in a one-semester course is obviously impossible. We could hope for no more than to provide the minimal background for college algebra. We tried to achieve this hope by maintaining a rapid pace and by deleting, with reluctance, some important topics. As a consequence, the totally unprepared student was frequently unable to maintain the pace of the review course, while the partially prepared student bored by the elementary beginning, was subsequently driven too fast through the intermediate topics. By the spring of 1968, we had concluded that a one-semester review course did not solve the problem. But time and statistics were required to convince our administration.

By using a uniform departmental final examination in the review course (all graded on the same scale) and by peppering the president and the academic dean with a constant barrage of statistics, we had convinced them by the spring of 1969 that our one-semester catchall course was an insufficient remedy for the widely, indeed wildly, varied mathematical backgrounds of our freshmen.

Expanded Review Course

We therefore divided the review course into two one-semester courses: beginning algebra and intermediate algebra. One paramount factor promoting that decision was the fact that the mechanics of basic algebra must become a part of the student's ready knowledge if he or she is to succeed in the first two years of college mathematics. Drill is an effective way to achieve this readiness, and two courses would have allowed for more drilling time.

Providing time for drill was not the only objective for the expanded review course, however. We also hoped to achieve a slower, more realistic pace in each course, to include important topics formerly omitted for lack of time, to give the totally unprepared student the psychological advantage of a better chance for success in his first course, to offer the better but underprepared student a more thorough and complete treatment of intermediate topics and to avoid repeating topics already mastered, and to achieve greater efficiency and flexibility in student placement.

Our present program screens students by using the placement test during each registration period and also by offering (to qualified students) advanced-standing examinations in college algebra and in trigonometry. Consequently, a freshman may begin his or her study of mathematics at any one of four different levels, depending on his or her performance in the various tests. The original placement test has been expanded and changed into a double-tiered structure with specific cutoff scores for intermediate algebra and for college algebra. Now we await the initial results from the new two-semester program and hope to cut the mortality rate in college algebra by at least another 50 percent.

Other Changes

Besides changes in the actual test, other developments have occurred both in and because of our program. As a result of the continuing decline in student failures, the procedure initially developed at the college for testing and placing freshmen in mathematics has been expanded to include all students enrolling in mathematics. All students must now have departmental approval slips to enroll in any mathematics course except beginning algebra and practical arithmetic. This is accomplished by setting up one station at registration to check mathematics prerequisites for all former UHDC students and a second station to administer advising and placement testing to all new students, including transfer students. We now also have placement testing for four different levels of mathematics: intermediate algebra, college algebra and trigonometry, elementary functions, and the first course in calculus.

Very likely the most important addition to the placement program since 1970 was the introduction in 1971 of the "sample placement test." For each type of placement test offered, we have a prototype sample placement test (with answers included) that is available to students at all time; furthermore, all students are required to look over a sample test before they take an actual placement test. The fringe benefits of the sample-test ploy have been enormous: after looking over the sample tests, many students voluntarily place themselves in a lower-level course; other students reconnoiter their background skills with the help of the sample tests and enter higher-level courses with a refreshed memory and increased confidence; all students are happier with the placement program as a result of having the sample test preview.

Program Results

The offering of multilevel placement tests and the availability of corresponding sample tests in advance have resulted in a steadily increasing enrollment and retention of students in mathematics for the past ten years. The nature of the increase is probably best exemplified by two sets of statistics: the enrollment in mathematics at UHDC has increased over the ten-year period from 22 percent of the student body each semester to more than 55 percent of the student body each semester for the past four years; and of the academic departments at UHDC, the mathematics department now generates the second highest number of student credit hours per semester, next only to the humanities department, which encompasses English, speech, music, drama, art, philosophy, and logic. Surprisingly, the gap between the student credit hours generated by mathematics and humanities is decreasing, and if current trends continue, it is projected that by fall 1980 the mathematics department will generate a greater number of student credit hours than any other academic department in the college.

Conclusions and Recommendations

Beginning with the information gleaned from our first investigations in 1966 and continuing on to our present program and to the valuable information now being provided through Committee on the Undergraduate Program in Mathematics (CUPM) meetings and publications, we can sum up our conclusions about first-year mathematics in junior colleges in six statements.

1. A majority of junior college freshmen have deficiencies in mathematics that range from partial to total.
2. Records show that these deficiencies do not necessarily imply a lack of ability. They frequently spring from insufficient high school training and/or a time lapse between high school and college.
3. For students of normal or above-normal ability, these deficiencies can be effectively removed by a review course of one or two semesters. Our experience leads us to believe that the two-semester plan is the better one for any college with an open-door policy.
4. Presidents and academic deans of colleges need to be aware that short of returning to high school, students with serious mathematical deficiencies have no way to improve without such a review course or courses. This is especially true of mathematics because of its cumulative nature.
5. Placement tests for entering freshmen as well as advanced-standing examinations (in college algebra and trigonometry) for well-prepared students provide an efficient way to achieve accurate student placement.
6. The results of our investigation support the philosophy that any junior college that maintains an open-door policy to all high school graduates accepts responsibility for providing students with courses in which they have a reasonable chance to succeed.

June P. Wood is chairman of the department of mathematics and computer science at the University of Houston Downtown College (formerly South Texas Junior College) and is author of five textbooks (two more in preparation). She was named "Piper Professor" for outstanding teaching in 1975 by Texas' Minnie Stevens Piper Foundation and served as second vice-president of the Mathematical Association of America, 1973–1975.

The attrition of community college transfer students who major in science at the university is rapidly increasing. Stemming this tide will require novel and innovative solutions.

Stopping the Attrition of Science Transfer Students

Arlene A. Russell
Patricia L. Perez

Much of the growth in the community colleges during the last decade has occurred in occupational, educational, and community service programs. Nonetheless, community colleges, "were, are, and will be evaluated to a major degree upon the success of their transfer students to the four-year colleges and universities" (Cosand, 1979, p. 6). One must therefore view with alarm recent data from the University of California system presented in Table 1 that indicate that there is a rapidly increasing rate of attrition among community college transfer students because of academic difficulty.

The numbers in Table 1 apparently underestimate the extent of the problem. The University of California (1980) found that many students voluntarily withdraw before academic performance has dropped low enough to warrant being placed on probation. Their withdrawals are, however, associated with academic difficulties. Attrition is even more severe in the physical sciences, mathematics, and engineering and may be as much as 50 percent higher than the data in Table 1 indicate (California State University and Colleges, 1979). There are, of course, many other reasons for attrition besides academic difficulties. These have been extensively considered elsewhere (Cope, 1978 and references therein).

Table 1. One-Year Attrition Rates for Community College Transfers Who Entered in 1972, 1974, and 1976

	Good Academic Standing			*Academic Difficulty*			*Total*		
Campus	*1972*	*1974*	*1976*	*1972*	*1974*	*1976*	*1972*	*1974*	*1976*
Berkeley	13	14	11	10	11	12	23	25	23
Davis	NA	16	13	NA	9	10	NA	25	23
Irvine	22	17	15	4	10	15	26	27	30
Los Angeles	11	10	8	12	15	22	23	25	30
Riverside	15	17	17	10	8	10	25	25	27
Santa Barbara	NA	NA	NA	NA	NA	NA	NA	NA	NA
Santa Cruz	25	22	20	5	9	12	30	31	32
San Diego	25	23	16	12	10	12	37	33	28

Source: University of California Systemwide Administration, 1980.

Inasmuch as grade-point-average (GPA) is a measure of academic success or failure, this difference in attrition by major is consistent with Anderson's (1977) and Menke's (1980) observations. They found that the average GPA of community college transfer students was lower than the average GPA of "native" students who began their postsecondary education at the university. Additionally, when they considered GPA's by disciplines, they found that in the physical sciences, mathematics, and engineering the GPA of the transfer students was the lowest of all disciplines and that the difference between transfer students' and native students' GPA was the greatest. It is therefore not surprising that attrition is as high as it is in these disciplines.

As well as terminating because of academic difficulties, many transfer students in these areas change their majors to "easier" fields to prevent dismissal. Consequently, the net attrition of students from the science disciplines is substantially higher than the average attrition data indicate. Data from the School of Engineering at the University of California, Los Angeles show the overall attrition of community college transfer students changing from 33 percent to 50 percent between 1972 and 1975. At the present time there is little other available longitudinal data on attrition of community college students by discipline.

If the academic science programs in the community colleges are to maintain their credibility, methods for decreasing the attrition of their transfer students must be developed. Additionally, longitudinal data including disciplines of students must be collected on state and national levels if effective solutions are to be developed and assessed. This chapter is an attempt to consider some possible causes for the difficulties of science transfer students and to suggest some possible solutions that might improve the success rate of community college science transfers at the university level.

The Hierarchy of Knowledge

In the physical sciences, perhaps more than any of the other disciplines, subject knowledge is hierarchical. If transfer students do not have the same basic training in foundation courses as native students, then their ability to successfully complete the baccalaureate degree in the sciences at the university is seriously jeopardized. In a system of higher education where students are tracked by high school grades, articulation agreements notwithstanding, the fact is that the level of instruction in the physical sciences in community colleges, state colleges, and universities differs. If, for instance, one looks at the texts used in the first-year general chemistry courses taught throughout California, one finds that topics are similar but the level of coverage is not. Even the prefaces of the textbooks indicate the variability of instruction. Table 2 contains extracts from the preface of three of the most widely adopted texts in California. Since the topics covered in each book are the same, the articulation agreements are met. Unwitting transfer students are oblivious of the difference between their backgrounds and those of native students until they have begun subsequent courses at a four-year institution.

Preparation

There appear to be many interrelated causes for this difference in instruction. Students, faculties, and university and community college administrations all are involved. Increasingly, non-transfer students are enrolling in courses originally set up to meet articulation agreements with the universities. In responding to the valid but different needs of these non-transfer students in the course, instructors have lowered the level of their instruction — to the detriment of the transfer student.

Table 2. Portions of Prefaces of Widely Adopted General Chemistry Texts

[This book] "is designed to be used in a general university chemistry course which must provide both an overview of chemistry for nonspecialists and a sound foundation for later study for science and chemistry majors." — *Chemistry Principles* (3rd ed.) Dickerson, Gray, and Haight (1978).

"We have also been influenced by the changing composition of the student body in general chemistry. Very few of our students are chemistry majors — most of them are preparing for careers in engineering, the biological sciences, medicine and allied professions." — *Chemical Principles* (4th ed.) Masterton and Slowinski (1978).

". . . we have assumed a mathematical background sufficient to handle only simple algebra . . . In developing concepts we have tried to limit the use of mathematics." — *General Chemistry Principles and Structure* (2nd ed.) Brady and Humiston (1978).

Nowhere is the complaint that students are not as well prepared as they used to be heard more frequently than at community colleges. The decline in Scholastic Aptitude Test (SAT) scores is supported by considerable anecdotal evidence from instructors that students do not have the critical thinking skills and mathematical background to handle mathematical approaches to the lower-division physical science courses (Hayes, 1979). University admission requirements play an important role in the high school training of all college-bound students. Students who plan to obtain a baccalaureate degree are influenced in their choice of high school subjects by university requirements. All too often, the weaker the student is academically, the fewer the courses that he or she takes beyond the minimum university admission requirements. The community colleges bear the brunt of these lowered university admission standards.

Although not specific to science preparation, national data on high school GPA's of first-time full-time college freshmen (American Council on Education, 1970; Astin, King, and Richardson, 1978; Astin and others, 1974) indicate that the difference between students in universities and in community colleges has remained relatively constant during the last decade (Table 3). Although first-time, full-time students are not the majority in community colleges, this group is most likely to pursue a baccalaureate degree at a four-year institution (California Postsecondary Education Commission, 1979). It would appear then that the increase in the rate of failure of transfer students cannot automatically be attributed to an increasing difference in initial student populations at the two levels.

Because the rapid growth in community college faculties took place during the early 1970s, the general and gradual decline in the preparation of all students as indicated by the decline of SAT scores occurred after most of the community college faculty had close and personal contact with students in four-year institutions. As a result, the community college instructor's memory of the abilities of students in four-year institutions reflects a time when the student had a much better preparation in science and mathematics than the students who are presently entering these colleges and universities. The actual difference in abilities between students presently in the two levels is less than is

Table 3. Preparation of Freshmen at Community Colleges and Universities Between 1970 and 1978

	High School GPA					
Year	*All Institutions*	*Community Colleges (1)*	*All Universities (2)*	*Difference (1) – (2)*	*SAT V*	*SAT M*
1970	2.89	2.63	3.11	0.48	460	489
1974	3.04	2.78	3.20	0.42	444	480
1978	3.07	2.87	3.30	0.43	429	468

commonly believed by the community college faculty. Because the movement of students in nonoccupational programs is for the most part one-way (from the community college to the four-year institutions), community college instructors have little opportunity to correct their misconceptions. The net effect for the transfer student is disastrous.

Compensatory Needs

Nonetheless, compensation must be made for the poorer preparation of incoming college students at all levels. Time must be spent in the community college classes on topics formally covered in high school classes. This automatically decreases the time available for college-level work specified by articulation agreements. Depth is sacrificed for breadth. All too often the instruction in the most difficult areas of the subject is superficial and cursory.

In addition to the community college faculty's lack of contact with the university-level student and its response to the changing student population, the decline in enrollments in the academic majors is also affecting the level of instruction. Faculties are being pressured both subtly and overtly by administrators and peers (Hinrichsen and Schaumberg, 1976) to maintain the enrollments, often by making courses easier. As they become less mathematical, less detailed, less rigorous, students become less qualified to transfer to the university. This result seems short-sighted in light of Lombardi's suggestion that: "Community colleges confronted by reduced financial resources revert to the traditional higher education status with emphasis on college credit courses and programs" (1979, p. 4).

Improving Preparation

During the 1970s, the interests of society and students shifted from the physical sciences to the health sciences. The lower-division physical science courses became a means to a baccalaureate degree leading to graduate studies in medical and health-related fields. As a result, the number of graduate students in the physical sciences declined. Concurrently, enrollments in the science courses at community colleges have declined. Consequently, community college science faculties form a reserve of highly qualified teaching personnel that might be tapped as a source of instructors for the parallel transfer courses in the universities.

At a time when community college instructors are concerned with job security, retrenchment policies of administrators, and public apathy, recruitment and recognition by other levels of higher education would raise faculty morale. This alone would be an incentive for faculty to improve the level of instruction in their classrooms. By acquainting community college faculty with the present university-level student, a new set of realistic and higher expectations could be developed in the community colleges for the potential transfer students.

Academic freedom in universities tends to allow faculties to appoint qualified individuals to temporary teaching positions with a relatively small amount of administrative bureaucracy. Appointing community college instructors as "visiting faculty" would involve well-established and easily implemented procedures. Leaves could be arranged for one or two terms that would allow the community college instructor to pursue innovative course development or professional development along with his or her teaching assignment in the host four-year institution.

With the possible exception of the use of professional development leaves in conjunction with the faculty transfer program, this proposal is actually cost effective for local community college districts. As enrollments decline in community colleges, the four-year institutions effectively "share" the salary of the tenured faculty. Even if it were necessary to hire a part-time instructor at the community college to teach some of the tenured member's course load, the overall cost to the community college district would be less. Additionally, noninstitutional money could be sought from federal or state funds to support the development of this kind of cooperative program.

Pretransfer Term

A second solution that would improve the chance of success of transfer students in the sciences—the development of an optional but strongly recommended pretransfer term at the community college for students in the physical sciences—is expensive to implement and maintain but is also important and necessary. Rather than trying to upgrade regular courses where many of the enrollees do not plan to continue in the physical sciences, this term would be based on a tutorial system in which the needs of the pretransfer student could be individually assessed and met. A special curriculum in mathematics and science subjects on which the student will be building in the junior and senior years would be set up for each student. This term would not be unlike the terms set up for preparation for national examinations that are prevalent in Europe.

The tutorial format of this term would allow the pretransfer student who understood the fundamentals introduced in the regular courses an opportunity to develop a compentency in the more difficult areas of the transfer topics and to experience the courses in a more rigorous manner. Requiring students to work independently at the community college level may also lessen the transfer shock commonly experienced by these students. Implementation of such a pretransfer term will require careful and delicate considerations of articulation agreements and established policies as well as a firm commitment from community colleges and universities to try to improve the level of preparation of the community college transfer student.

Conclusion

The increases in the number of nontransfer students in community colleges in the last decade has significantly affected instruction in the courses that are used by students seeking baccalaureate degrees. Science students transferring to four-year institutions are increasingly lacking adequate preparation. It is time for community colleges to develop innovative solutions to meet the needs of these traditional students, who still see community colleges as their access to the benefits of higher education.

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Arlene A. Russell is the director of lower-division laboratory programs in the Department of Chemistry at the University of California, Los Angeles.

Patricia L. Perez is an instructor in the Department of Chemistry at Mount San Antonio Community College. She is a former president of the California Association of Chemistry Teachers.

Classes with large numbers of passive, part-time students pose an important instructional problem. Engaging diverse individual students in a productive learning process can make a difference.

Individualizing Instruction: A Systematic Approach

Fred A. Thompson

In the sciences as in all other fields, the primary goal of teaching is learning. Learners vary immensely in their aptitudes, motivations, backgrounds, and maturity. Nearly every index of student attributes (scholastic ability, educational goals, ethnicity, age) is distinguished not by its central tendency but by its measure of dispersion. Teaching to the "average" will therefore fail to harness the diverse characteristics of students in a manner most conducive to learning.

The college teacher's role is to organize and orchestrate resources (teacher, students, and media) in an attempt to optimize learning. The standard method of lecture, assignments, and testing loses too many students along the way through attrition and through failing to meet minimum learning goals. It is still useful to have a common instructional process, to establish course standards, and to schedule deadlines for accomplishing learning tasks. A sense of goals, progress, and accomplishment is essential for teachers and students alike. But within the framework and pace of the standard course there are opportunities to utilize instructional resources more effectively on an individualized basis.

Many people consider individualized instruction as a one-to-one teacher-student encounter. Obviously, the ideal one-to-one conditions seldom exist, particularly when large numbers of students are involved. The depersonalization of education is first and foremost a problem of information. Information should be available in such a manner as will facilitate the tailoring of individualized learning sequences for students who need to increase their learning in specific areas. As the teacher monitors information feedback, it becomes possible to vary pace, erase confusion, alleviate boredom, avoid unnecessary busywork, and provide personal help for those specifically identified as needing assistance. Remediation therefore encompasses the entire instructional system—if the teacher has adequate information at hand.

Instructional System

The most significant teaching activities occur outside the classroom. The preparation and ongoing remediation that feed into a course will in large measure determine student success in achieving learning goals and objectives. The development of a systematic approach to learning is a series of choices about ends and means. Decisions on what, how, and for whom learning will take place are unavoidable. Additionally, there are many subsidiary questions involved in preparing for, providing, and evaluating learning outcomes.

Course Outlines. The scope and boundaries defined in a well-prepared course outline can do much to organize the goals, content, and pace of learning. Such an outline may contain week-by-week dates, lecture topics, reading assignments, due dates for homework, quiz and examination dates, and scheduled special learning events. Such advanced scheduling necessitates planning the course and structuring overall content according to broad goals. Major learning activities must be planned at this point. Basic instructional materials used by students may also be selected. These course outlines should be distributed to students.

Instructional Units. Within each course there are several related topics that may be called *instructional units.* Each instructional unit may be further divided into *concept areas* that represent significant chunks of information. For example, an instructional unit from economics might be divided into three concept areas as follows:

Concept Area 1. The production possibilities model of economic activity
Concept Area 2. Market capitalism, state socialism, and the mixed economy.
Concept Area 3. The circular flow of economic activity: resources and output, income and spending.

Learning Objectives. Within each concept area it is extremely useful to write definite learning objectives to serve as a guide for instruction, a guide to learning, and as criteria to evaluate learning outcomes. These learning objectives should specify what the learner is expected to be able to do, how well he should be able to do it, and under what conditions he is expected to perform.

Unfortunately, many teachers become bogged down in writing, rewriting, and refining objectives. They abandon the task as too time consuming and unnecessary. Yet, by asking: "What am I trying to accomplish?" the teacher is sensitized to learning tasks that must be completed.

To avoid intimidation when composing learning objectives, remember that no statement of learning outcomes is expected to be perfect or final. Specificity is essential, but one may streamline objectives by leaving out irrelevant, commonly understood conditions or second-order constraints that unnecessarily complicate such objectives.

Start with ready-made objectives found in many textbooks, study guides, manuals, and other sources. Adapt these learning objectives to the course structure you have created: modify objectives that are ill suited to your instructional intents; eliminate objectives that are inappropriate; write instructional objectives to fill in gaps, to refine otherwise satisfactory sequences, or to create original units and concept areas.

While these learning objectives are probably incomprehensible to someone outside a given field, they do serve as advance organizers for instructors and students alike. Carefully stated objectives provide an efficient way of planning teaching activities: students have a good idea of what is expected of them; the teacher can therefore concentrate on demonstrating or explaining desired learning outcomes instead of course structure.

Such learning objectives are also useful in selecting or writing quiz and examination questions. "Teaching one thing and testing for another" is a common student complaint. If questions reflect clearly stated learning objectives, then such misunderstanding is less likely.

Finally, learning objectives form the basis for establishing adequacy criteria for each concept area. If quizzes on instructional units reveal that preliminary learning proficiencies are unsatisfactory for a concept area according to explicitly established standards, then remediation is in order.

Instructional Treatment

Variety is helpful in presenting or demonstrating information and skills. Instructional techniques should be employed on the basis of their potential to accomplish particular affective or cognitive objectives with learners. Lectures, discussions, and visual aids can stimulate—or stifle—student involvement and interest. Any focus on media should be tempered with the realization that many prepared materials are costly to purchase, inappropriate for many of the specific objectives of your course, and time-consuming to preview and incorporate effectively in the instructional sequence. It is therefore preferable to use a few effective aids than to run an irrelevant multimedia sideshow.

Still, there is an important need for alternative instructional aids for specific concept areas. For many reasons, some students will need auxiliary instructional treatments for various concepts areas. Programmed books, teacher-prepared learning units, or self-instructional cassette study-guide modules can be of great value to students who require a supplement to the standard treatment. Whether the auxiliary treatment be a problem, a book, or a multimedia module, it should be targeted for a specific learning deficiency and involve active student response. Such options provide the instructor with alternative learning prescriptions for students diagnosed as requiring extra help.

Sampling Cognitive Learning

Composing tests and evaluating information they provide are important aspects of a teacher's responsibilities. Midterm or final examinations are not very useful in providing information on current learning problems facing the students. By the time of the "big exam," some students have fallen behind, some have missed important concepts entirely, and some are irretrievably lost. The information provided by the final will help no one. It only denotes winners and losers. Frequent quizzes can be much more effective in providing valuable feedback on student progress in understanding concepts and performing the learning outcomes specified by learning objectives.

The teacher should decide what level of achievement is acceptable in each concept area. If concepts or skills are absolutely essential to understanding future course material, then 100 percent correct responses might be desirable. Typically, 75 to 90 percent performance may indicate a need for optional student reviews or brush-up work prior to examinations. Lesser scores may indicate the need for remediation.

Feedback to Students

When administering quizzes, it is desirable to view them as diagnostic tools rather than as measures of final achievement. Based upon teacher-determined adequacy criteria, decision rules for each question grouping (three to five questions sampling concept area mastery) can be created to prescribe meaningful and pertinent individualized student assignments. Prescriptions may vary from no mandatory assignment to optional brush-up assignments to required remedial assignments for students who fail to meet adequacy criteria in one or more concept areas. In devising and prescribing such assignments for large numbers of students, a computerized test-scoring service with item-analysis printouts for each individual student is almost essential. Programs designed specifically for such applications are also available (Kelley, 1973).

By tailoring assignments for the individual student, needless busywork is avoided. Students who do need additional attention or practice are given a prescription suitable to their needs. Rather than repeating assignments, students who have not attained satisfactory performance in concept areas can be given auxiliary instructional treatments. This avoids the sense of failure associated with doing the same assignment again and helps to enliven student interest.

Student assignments should be turned in along with prescription sheets or item-analysis printouts. Each assignment should be read, scored, and graded. When students know that their work will be scrutinized, commented upon, and recorded, they take their assignments seriously.

Feedback to the Instructor

By monitoring student progress, tailoring assignments to individual student needs, and grading remediation work performed by students, the instructor gains timely information on the weaknesses and strengths of the educational program. This information allows the teacher to correct deficiencies and modify instruction when it will do the most good.

If the class as a whole performs poorly in a particular concept area, then mass remediation may be more appropriate than meting out the same individualized assignment to large numbers of students. The focus on learning effectiveness and instructional procedures leads the conscientious teacher to refine and modify teaching approaches in light of results being achieved by learners.

Instructor feedback can also be gained from the student who needs personal help. Good record keeping will reveal cumulative difficulties being experienced by a few students. An appointment for personal counseling may help these students, or enable them to better cope with the problem at hand.

Examinations

Examinations should sample learning encompassed in several instructional units. The test items selected should not be identical to quiz questions, nor should the questions selected necessarily test for the identical learning objectives. Effort should not be directed toward teaching to a test or encouraging rote memorization of test items. Rather, effort should be focused on content mastery throughout the instructional units, concept areas, and learning objectives covered by the examination.

In this regard, a normal curve that assigns a certain percentage of students a specified grade regardless of absolute performance is a fraud. If one is conducting educational research, then tests that have high difficulty and discrimination indexes are appropriate. Scores should be spread and established statistical properties should be used to interpret and analyze data. But if one is assessing learning achievement, the aim is to determine whether and to what extent students have mastered specified learning objectives. In such a context, criterion-referenced grading is preferred.

One way to construct such a grading system is to set minimum performance standards for essential tasks that all students should be able to master. Additionally, minimum performance standards for higher level questions or tasks that many students may never fully achieve may be established.

Experimental Findings

The effort to individualize instruction obviously has its costs. Hours spent in planning, preparing a detailed course outline, sequencing instructional units, dividing each instructional into concept areas, writing specific learning objectives for each concept area, preparing frequent quizzes, prescribing individualized assignments based upon item analysis of the quizzes, reading or grading those assignments, modifying the instructional process, preparing examinations, and so on and so forth—these are very real costs. Is teacher time spent doing these things worth giving up other uses of the same time?

A careful study conducted at Riverside City College (Thompson, 1978) gives some clues. Four achievement tests were given in an economics course to two groups of students: an experimental group receiving individualized instruction, and a control group given conventional (lecture, textbook, examination) treatment. When all factors that might influence learning achievement were taken into account, the effort to individualize instruction was found to increase the average student examination score by a statistically significant 10 percent. The level of benefits of individualized instruction would increase the class average from 70 percent to 77 percent on achievement tests.

Who benefits the most from individualized tests? A highly structured course that encourages good study habits (such as distributed learning) and that has built-in remediation could be expected to benefit low-ability, low-achieving students more than high-ability, high-achieving students. That is exactly what was found at Riverside. When student examination scores were grouped according to previous grade-point average (GPA), high GPA students (3.38 and above) improved 18 percent through individualized instruction. Low GPA students (2.20 and below) improved 31 percent. When student examination scores were grouped by School and College Ability Test (SCAT) scores, high SCAT students (T = 310.3 and above) improved their average score by 4 percent. Low SCAT students (T = 283.5 and below) raised their scores by 26 percent through individualized instruction.

If motivational factors are taken into account, the results are even more striking. High achievers (average or lower SCAT with high GPA) improved their average score by a mere 3 percent with individualized instruction. Low-achieving students (average or better SCAT but low GPA) improved their examination scores by 29 percent over similar control group students.

High-ability students may have run into the "ceiling effect" of the

100 percent maximum examination score. It is far more difficult to improve a score from 85 percent to 90 percent than it is to improve a score from 60 percent to 70 percent. Additionally, some students seemed to be "satisfiers" who aimed for a specific course grade. They viewed the certainty of a structured course and time-saving study procedures as a way of obtaining a desired grade with less effort.

Student reaction to individualized instruction was positive. A majority of the students (56 percent) had highly favorable comments, while only 6 percent had unfavorable feelings regarding individualized instruction.

Conclusion

The expenditure of time in planning and creating an individualized system of instruction is substantial, as is the time devoted to preparing quizzes, devising pertinent remedial instruction, and paying personal attention to the individual assignments completed by students. The benefits of this work accrue to students, many of whom would experience frustration and failure. But they will not immediately recognize the value of an extra increment of learning. Neither will the community detect any perceptible benefit.

The teacher may find an improvement in psychic income as his or her students achieve and perhaps excel in subsequent work and in life because of his or her efforts. But the teacher's pecuniary income will no doubt remain the same. And there are the extra hassles with administrators, clerks, and committees when attempting to implement innovative ideas. Eventually the teacher will have to ask: Is it worth it? And only the teacher can provide the answer. It is to be hoped that this chapter helps some teachers come to that decision more quickly.

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Fred A. Thompson is a financial economist with the Department of Housing and Urban Development. He was formerly assistant professor of economics at Riverside City College.

A biology course on women's sexuality, offered as an alternative to the general education general biology course, has proved to be popular and of value to men and women, as well as an aid in dispelling misinformation about and ignorance of women's own bodies.

Alternatives to the Standard Biology Course

Bette Slutsky

"The Biology of and About Women" was introduced into the curriculum of the City Colleges of Chicago about five years ago as a response to the needs of women to know more about themselves. Although reproductive biology was included in the subject matter of the general biology course, the topic discussed reproduction in plants and animals and was very limited in the time it could devote to human sexual biology. Since the new course dealt more with human sexuality and was primarily concerned with anatomy, physiology, development, pregnancy and birth, it naturally concerned women and their biology.

Just as a course in microbiology or botany deals with the principles of biology as applied to microbes or plants, so a course in the biology of women deals with these same principles as applied to women. Gonadal differentiation, growth and development of the sexual organs, principles of nutrition, genetics, and evolution, as well as the effects of the environment are all included. These topics are also included in a general biology course; however, in this course they are specifically applied to human growth and development.

Course Content

My course as developed over the past four years starts with a short overview of attitudes about women, their bodies, and their bodily functions.

Accepted practices, roles, and attitudes about women and their bodies are discussed. This short historical survey helps to put current ideas about women and their bodies into perspective, and students come to appreciate the ebb and flow of restrictive and permissive attitudes.

To understand the anatomy and physiology of the reproductive organs properly is to understand them from an evolutionary and developmental perspective. Both genetic and environmental influences affect the development of adult sex organs. We therefore discuss the origin and development of gonads and accessory sex organs from conception to birth. The focus is on the contributions of chromosome number and kind and the contributions of hormones to the normal fetal development of internal and external sex organs. Abnormalities in chromosome number and kind as well as hormone excess or deficiency are discussed.

A developmental model that describes the evolution of sexual identity throughout the various stages of life is used. The significant biological events of each stage are discussed, with special emphasis on the maturing process and the reproductive years.

It is only after these introductory and developmental concepts are described and discussed that normal adult reproductive anatomy and physiology are introduced. We begin with the male, whose sex organs develop from the essentially female embryo due to the presence of the "y" chromosome and its influence on the production of the male sex organ producing hormone testosterone. Understanding the biological functions of the male is essential for any informed male or female. Internal and external sex organs, their functionings, diseases, and common abnormalities are discussed.

After about five weeks into the course, we begin to learn about the woman's body. In addition to the descriptions of internal and external organs and their functionings, attention is given to the menstrual cycle (including menarche and menopause, dysmenorrhea and amenorrhea), breasts, conception, pregnancy and fetal development, parturition, contraception, venereal and other diseases of the reproductive tract, and human sexuality.

At the time when the structure and function of and emotional attitudes about breasts are discussed, the school nurse is invited to speak about breast cancer and demonstrate breast self-examination on models of the upper torso. This visit and talk have proved to be one of the highlights of the course. One semester, a mature student, after hearing the talk, seeing the demonstration, and doing breast self-examination, discovered a lump on her breast. It was malignant and she had a mastectomy. She returned to class within a week, very thankful to have discovered it "in time." She also returned to visit classes in subsequent semesters to encourage other students to perform this examination. She claims that taking the course saved her life.

Understanding variations in human sexual behavior contributes to self-knowledge. Kinsey (1953) and Masters and Johnson (1966) have contributed to our attempts to understand this complex aspect of human behavior.

Physiological response, similar in many ways in men and women, and sexual outlets are discussed in the course in a nonjudgmental way. I use the term *varieties of behavior* rather than *abnormalities of behavior,* and I attempt to present whatever evidence there is for the development of the different ways of sexual expression. The possibilities of hormonal, developmental, and environmental influences are discussed. Although we do not go into it in class, a section of the text deals with sex and the law, so that the interested student may refer to that section and have some questions answered.

The two testbooks that I use are Katchadourian's *Fundamentals of Human Sexuality* (1975), and *Our Bodies, Ourselves* (1976), by the Boston Women's Health Book Collective. The scientific basics in Katchadourian are countered by the down-to-earth and practical approach in *Our Bodies, Ourselves.* Although I do not agree with all the self-help advice in *Our Bodies, Ourselves,* I feel it is important for students to get this point of view, so often neglected by scientists in their discussions of women and their bodies.

Why Offer Such a Course?

If general education, a long-time and traditional function of the community college, is still considered a meaningful objective (and there is a good deal of doubt in some community college circles that it has any value for present students), what possible forms may it take? The model used in the City Colleges of Chicago has been the general education core used by the University of Chicago, adopted and adapted to the community college more than forty years ago. A year each of English, social science, physical science, biological science, and humanities was required for graduation with an A.A. degree, with the focus on the transfer student.

With the continuous decline in transfer students, and with the elimination of most general education requirements from the career and vocational programs, enrollments in the general courses, including the sciences, declined. In an attempt to ensure enrollments in biology and to offer other choices to students, it became the policy to permit students to substitute any two biology courses for the general biology courses formerly required for graduation. When the associate degree program in nursing began at Mayfair College (the predecessor to Truman College), students were permitted to substitute two anatomy and physiology courses for general biology courses. Chemistry was a substitute for physical science courses and psychology a substitute for social science. In addition, students left general courses as colleges and universities in the area eliminated biology as a requirement for graduation.

So, there we were with our bare classes hanging out. We could not go back to our old electives. Long gone were comparative anatomy and embryology courses, no longer required for pre-med. Fading gradually were classes in zoology and botony. New courses were added to help attract students: human ecology, human genetics, human biology, consumer-oriented nutrition. Why not, then, a course of and about women and their bodies? Indeed, why not men, too?

Over four years ago, I initiated the women's course at Mayfair College. From that time on, it has been very successful; indeed, for the past two years, there has been enough interest for two sections, one day and one evening, with the evening section taught by a male instructor. The popularity of the course is such that we will soon offer three sections. And its appeal has not just been to women—from the first time this course was offered, men, ranging from police officers to the president of the student government, have enrolled.

The course is described as being designed to help students understand the structure and function of women's bodies and the factors involved in the development of their sexuality; to become more aware of the choices available in the making of decisions about women's bodies; to recognize the similarities of all women and yet their uniqueness as individuals; to become self-confident, autonomous persons. The course can be used as an alternative to one general education biology course for three credit hours.

Conclusion

If there is a future for general education science in the community college (a proposition I sadly do not take for granted) and if a course in the biology of women can be in students' interests by providing motivation for learning as well as academic training in the principles of biology, then it is a good alternative to the traditional course. It is not a watered-down course—it serves an important need. In serving as a means of overcoming the lack of understanding of the biological basis of many of women's problems and in serving the needs of the community for courses related to its problems, this course deserves a rightful place in the curriculum.

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Bette Slutsky is professor of biology at Truman College, one of the City Colleges of Chicago, where she has taught since 1946. She was involved in an experimental interdisciplinary program where all five areas of general education were team-taught. She is former chair of the biology department.

Much of the psychology of teaching psychology involves capitalizing on students' eagerness for self-disclosure and learning from their own experiences

The Psychology of Teaching Psychology

Jana D. Osaze

Students register for a course in psychology for a number of reasons—they wish to better understand people, they want to explore the depths of their own personality, it is a course that fulfills a requirement for graduation, and so on. Whatever their initial reason for taking the course, however, students soon become captivated with the prospect of analyzing themselves, friends, and relatives. Much of the psychology of teaching psychology therefore involves capitalizing upon this eagerness for self-disclosure and channeling the direction of the course material toward meeting this need. Many of the basic principles of psychology have such direct applications that students often become enthralled with "finding themselves" in every topic covered in the class. As an instructor of such a course, one has the unique opportunity of stimulating an interest in course material by indicating an interest in exploring the students' own behavior.

Many students in an introductory course have not had the opportunity to take a psychology course prior to coming to college; therefore, many may have preconceived notions concerning the content of the class. The instructor may find that some class time must be designated for correcting popular misconceptions such as the belief that taking a course in psychology automatically entitles one to become the resident therapist of the neighborhood! I have found it important to explain to students that years of training are required to become a psychologist and that an introductory level course represents only a starting point in understanding human behavior.

Selecting a good textbook represents another topic of concern for the psychology instructor. An instructor's dream text would probably be one that is stimulating, exciting, informative, accurate, relevant, and readable. Large, bulky texts with small print and black-and-white pictures often serve to intimidate students. I have found that a text that is divided into ten to fifteen medium-length chapters creates less textbook anxiety than a text of twenty-eight to thirty short chapters. Students should also be encouraged to purchase the study guides that accompany texts.

Another strategy in the psychology of teaching psychology is to capitalize upon the common experiences of the students by utilizing their experiences as examples for practical applications of theoretical principles—the aspect of psychology with which most students are interested. A good text will have special sections of each chapter devoted to examples of practical applications. But do not hesitate to provide examples, practice exercises, or role-playing exercises using such topics as job problems, home and family issues, money management, time management, and parenting issues. For an additional perspective, you may even wish to draw upon a few of your own personal experiences as examples.

Psychology instructors are a unique entity for students in that they often may be trained therapists as well as instructors. Students will often rely upon their psychology teacher to help them solve their personal problems. One always knows when a psychology instructor has office hours by observing the line of students outside the door patiently waiting for a five-minute therapy session! I mention this only to emphasize the fact that the instructor of psychology is seen not only as an imparter of knowledge but is often also seen as a helping friend.

Students of psychology are interested in exploring their thoughts, desires, dreams, and wishes. One method that I have found to be quite effective in addressing this interest is the use of a battery of personality inventories. The inventories must be selected carefully, however, in that they must lend themselves to interpretations that are not heavily laden with value judgments. For example, it is not suggested that any form of intelligence test be included in the battery, since they may represent a threat to many people. If students are informed that the inventories only represent *different* perspectives on human behavior, one finds that students relax and enjoy this process of self-disclosure. The inventories often serve as a vital link between the course material and the student's personal experiences.

Inventories

Here is a description of the inventories that my students have most enjoyed. Since they all can be administered and interpreted within a period of thirty minutes, an instructor may wish to choose any combination of inventories according to his or her purpose and teaching style. Although these inventories were developed primarily for use in the field of psychology, many counselors and educators of other areas in the social sciences have found that they make relevant and stimulating course material for instructional purposes or for personal development seminars.

Learning and Memory. Many students believe that they have less than perfect memory systems. A typical complaint is of the frustration experienced from studying many hours, memorizing and repeating information, only to discover that few of the items studied appeared on the exam. Others confess to becoming so nervous at test time that a mental block develops and there appears to be no memory for the information. Study habits inventories, such as the one devised by Wrenn (1972) and the Study Attitudes and Methods survey (Zimmerman, Michael, and Michael, 1972), can help students identify specific areas of difficulty (a need for improvement in vocabulary, comprehension, note-taking and study techniques, habits of concentration, and so forth). These inventories address several areas of skills necessary for college success and provide an assessment score and an evaluation rating for each skill. The scores on these inventories indicate each student's areas of strengths and weaknesses.

Motivation. Rotter's (1966) locus of control inventory provides an assessment of the internal versus external control aspect of personality. The inventory is designed to identify feelings of personal control that may be of concern to students. Rotter's theory proposes that people who demonstrate an external locus of control perceive that they have relatively little control over their life circumstances, often attributing events to luck. People who display an internal locus of control perceive their life circumstances to be directly related to their own actions. These are people who perceive themselves to be the controlling factor in determining their life events. As a class exercise the teacher may wish to explore the various reasons underlying beliefs of personal control.

Thomas's Four Wishes Inventory (1958) reveals one's priorities in life by providing an assessment of four key areas of wish fulfillment: security, response, recognition, and adventure. Students are instructed to rank-order (from a rank of one to a rank of four) several groups of statements consisting of four alternatives. Each alternative represents one of the four areas of wish fulfillment. A rank of one is given to the statement that is most descriptive of oneself, and so on. Ranked scores are then converted into percentile scores that provide a general picture of the relative importance of the four areas for each individual. Thomas has also provided an accompanying interpretation sheet that describes each of the four wishes in detail.

Personality. The Neymann-Kohlstedt test for Introversion and Extroversion (Varnum, 1958) provides an assessment of the social-aggressive dimension of the personality. The introverted personality may be described as cautious when confronting new situations, concerned with realistic alternatives, shy, and in need of order, discipline, and design. The extroverted personality may be described as bold, daring, flexible, self-motivated, people oriented, and in need of personal freedom. Of course these descriptions represent two extreme themes of the social personality. Students are encouraged to discuss and validate the introversion-extroversion characteristics in terms of their own personalities.

Cognitive Processes. Creativity exercises often provide a nice diversion from the types of inventories discussed up to this point. The creativity exercises used at Los Angeles City College include convergent-divergent thinking exercises, ink blot exercises, visual pattern preference exercises, and puzzle and word-scramble challenge exercises. These exercises have been formulated to reveal specific identifiable themes or patterns of thought. Once the exercises are completed, students are encouraged to attempt to identify recurring themes appearing throughout their own inventory.

Creativity exercises also reflect the intellectual and emotional aspects of the personality. This may be assessed by presenting students with a hypothetical situation and noting their responses, and to this end the instructor may wish to obtain responses from the class and then organize those responses in categories. These categories of answers may be used as a basis upon which to discuss people's approaches to new and unique situations in everyday life. Particularly interesting answers may serve as special topics for class discussion.

Emotion. College students are typically functioning under tremendous amounts of stress. They often are unaware of the factors that contribute to this level of pressure, and this lack of knowledge can lead to a stress crisis. The Social Readjustment Rating Scale (SRRS) (Holmes and Rahe, 1972) provides a means of making students aware of the levels of tension and anxiety which exist in their lives. It lists significant life events and offers a rating scale of the relative contribution of each life event toward stress. Students should be cognizant of the clues for hypertension and ulcers. It is a good idea to couple the administration of the SRRS inventory with a discussion of relaxation and calming techniques.

The Inventory of Anger Communication (IAC) (Bienvenu, 1976) measures the degree to which one appropriately communicates anger. It is important to emphasize to students that anger is a normal human emotion often associated with frustration and conflict. The inventory is composed of thirty questions in which students indicate their typical reaction. A sample question is: "Do you admit that you are angry when asked by someone?" Each answer is weighted with a score from 0-3. A score of 70 or above is an indication that the student does communicate personal feelings when angered and that those feelings are communicated without intense physical or psychological ramifications. A score of below 70 may be interpreted as a tendency toward difficulty in communicating anger or impulsive, physical, aggressive reactions. Either method of expression is considered maladaptive because each can create *more* anxiety for the student. A class discussion of appropriate methods for coping with anger may follow.

Conclusion

Inventories may be administered throughout the semester, and once scored and interpreted, they may be compiled by the students into a personal psychograph. This may include a biographical sketch of the student, a summary sheet of the personality inventory tests and scores, an analysis of the scores for each inventory, personal opinions and accounts of relevant personal experiences, and a statement of the goals and objectives of the student for proposed behavior changes. Encourage your students to save their psychographs and to refer to their inventories periodically throughout their college careers. The psychograph can serve as a reminder of their process of self-exploration—one of the reasons they came to the course to begin with.

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Jana D. Osaze is an assistant professor of psychology at Los Angeles City College and a doctoral candidate in the Department of Developmental Psychology at the University of Southern California.

Resources for further information on teaching the sciences in two-year colleges.

Sources and Information: Teaching the Sciences

Donna Sillman

This concluding chapter highlights additional resources pertinent to this volume's theme: science education in two-year colleges. After a brief overview of general science education, the bibliography is arranged alphabetically by subject areas.

The Center for the Study of Community Colleges conducted an investigation of science and science-related curriculum and instruction several years ago (Cohen and Hill, 1978). A representative sample of instructors from 175 two-year colleges across the country provided information on class size, course objectives, teacher expectations, use of class time, use of instructional media, satisfaction with and source of instructional materials, student class activities, stressed competencies, grading practices, attendance requirements, interdisciplinary approaches, assistance in teaching, means of course improvement, and instructor's background. Hill and Mooney (1979) reviewed the research methodologies employed in the study and described the course-classification system.

Brawer and Friedlander (1979) summarized the findings and conclusions of the study and made recommendations to science and social science faculty. Because two-year colleges play a key role in developing science and social science literacy in this country, faculty in these fields must design distinctive courses and programs that make them attractive to the diverse populations they serve. The extent to which different areas within the social sciences are presented in the two-year college curriculum was reviewed by Friedlander (1979). He found that the range of transfer-oriented courses (other than general introductory survey courses) was very limited: very few social science courses were designed for occupational students, few colleges offered a general introductory social science couse for continuing education students, and developmental social science class were rare.

An example of what Southeastern Community College in North Carolina has done to reduce failure and attrition rates in the science department was reported by Scott (1979). Faculty members analyzed course offerings, identified specific course prerequisites, and developed instructional objectives. A study was done to correlate reading scores with science performance. In addition, placement strategies used by other institutions were reviewed and a science student needs assessment was developed.

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These ERIC documents, unless otherwise indicated, are available on microfiche, or in paper copy from the ERIC Document Reproduction Service (EDRS), Computer Microfilm International Corporation, P.O. Box 190, Arlington, Va. 22210. The microfiche price for documents under 480 pages is $0.83. Prices for paper copy are: 1–25 pages, $1.82; 26–50 pages, $3.32; 51–75 pages, $4.82; 76–100 pages, $6.32. For materials having more than 100 pages, add $1.50 for each twenty-five-page increment (or fraction thereof). Postage must be added to all orders. Abstracts of these and other documents in the junior college collection are available upon request from the ERIC Clearinghouse for Junior Colleges, Room 96, Powell Library, University of California, Los Angeles (UCLA), 90024. Bracketed publication dates are approximate.

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